WAVETEK

TEST AND MEASUREMENT
INSTRUMENTATION 1986

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WAVETEK®

How To Use This Catalog

This catalog contains descriptions, specifications, prices and ordering information for Wavetek's generator and measurement equipment along with related special equipment and components. Indexes and charts are included to help you readily find specific instruments and features.

• **Types of Equipment**—The table of contents below and a product index on page 4 will help you find the products you want. The general equipment type is also noted in the upper right of each page.

• **Equipment Model Numbers**—A model number index is on page 2. Also, instrument model numbers can be read in the upper left hand corner as you thumb the catalog pages.

• **Selection Guides**—Selection guides comparing features of many (but not all) instruments are on the following pages. Selection guide pages have a black edge for quick identification.

Frequency Synthesizers 91
Function Generators 8
Microwave Scalar Analyzers 129
Microwave Signal and Sweep Generators 128
Power Meters 129
Programmable Function, Pulse and Synthesized Generators 9
Pulse Generators 10
RF Signal Generators 93
RF Sweep Generators 92
Signal Processing Filters 11
Signal Switchers 162

Contents

Model Number Index 2
Product Index 4
Order, Warranty and Service Information 5
Wavetek Sales Organization 6
Wavetek Operations 7
Low Frequency Test Equipment . . . . 8 through 90
RF Test Equipment . . . . . 91 through 127
Broadband Cable Communications Test Equipment 125
RF & Microwave Components 126
Microwave Test Equipment . . . . . 128 through 155
Instrumentation Computers 156
Switching Systems 162
Rack Mounting 172
International Sales and Service Centers 174
United States Sales and Service Centers 176

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GPIB Identifies products that can interface to the General Purpose Interface Bus (IEEE Standard 488-1978)

ATE Identifies products that can interface to MATE (USAF Standard 2806763)

NEW Identifies new products

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Model Number Index

NEW **New products identified by bold type.**

Model	Description	Page
D151	RF Detector	126
D152	RF Detector	126
D153	RF Detector	126
D171	RF Detector	126
FB40	Return Loss Bridges	112
M151	RF Detector	126
NS20X	RF Source Modules for NS20 Systems	147
16	**Audio Output Impedance Adapter**	**90**
20	2 MHz Function Generator	18
21	11 MHz Stabilized Function Generator	30
22	11 MHz Stabilized Sweep Generator	32
23	12 MHz Synthesized Function Generator	34
75	**Arbitrary Waveform Generator**	**50**
132	VCG/Noise Generator	20
143	20 MHz Pulse/Function Generator	54
145	20 MHz Pulse/Function Generator	54
148A	20 MHz AM/FM/PM Generator	56
164	30 MHz Sweep Generator	64
166	50 MHz Pulse/Function Generator	66
171	Synthesizer/Function Generator	22
178	Programmable Waveform Synthesizer	68
182A	4 MHz Function Generator	24
186	5 MHz Phase Lock Generator	28
187	4 MHz Pulse/Function Generator	26
188	4 MHz Sweep Function Generator	24
190	20 MHz Function Generator	58
191	20 MHz Pulse/Function Generator	60
193	20 MHz Sweep/Modulation Generator	62
270	12 MHz Function Generator	36
271	12 MHz Pulse/Function Generator	38
273	12 MHz Sweep/Function Generator	40
275	12 MHz Arbitrary/Function Generator	46
278	12 MHz Synthesized Function Generator	44
432	Dual HI/LO Variable Analog Filter	88
442	Dual HI/LO Variable Analog Filter	88
452	Dual HI/LO Variable Analog Filter	86
601	Switching System Chassis	164
602	Switching System Expansion Chassis	164
603	Switching System Control Panel	166
604	Programmable Signal Switcher	163
610	200 MHz, 10 Channel Switch Module	166
611	500 MHz, 10 Channel Switch Module	167
612	250 Matrix Switch Module	167
613	General Purpose 16 Channel Driver Switch Module	168
614	High Power Switch Module	168
615	Low Level 10 Channel Switch Module	169
616	DC to 18 GHz Microwave Switch Module	169
617	250 MHz Attenuator Switch Module	170
618	1.5 GHz, Dual 1 of 4 Switch Module	170
619	Universal Breadboard Switch Module	171
620	DC to 26.5 GHz Microwave Switch Module	171
650	**Precision 2 MHz Variable Phase Synthesizer**	**12**
716	Multi-Channel Brickwall Filter	80
751A	Programmable Brickwall Filter	84
752A	Programmable Brickwall Filter	84
753A	Programmable Brickwall Filter	84
801	50 MHz Pulse Generator	72
802	50 MHz Pulse Generator	74
816	Programmable Multi-Channel Analog Filter	82
852	Dual HI/LO Variable Analog Filter	86
859	50 MHz Pulse Generator	76
904	3.7-7.6 GHz Signal Generator	130
907	7-11 GHz Signal Generator	130,132
907A	7-12.4 GHz Signal Generator	130,133
952	1-4 GHz Micro Source	134
954	3.7-7.6 GHz Micro Source	134
955	7.5-12.4 GHz Micro Source	134
957	12-18 GHz Micro Source	134
962	**1-4 GHz Micro Sweep Generator**	**140**
964	**3.7-8.4 GHz Micro Sweep Generator**	**140**
965	**7-12.4 GHz Micro Sweep Generator**	**140**
967	**12-18 GHz Micro Sweep Generator**	**140**
1018B	Microwave Peak Power Meter	154
1034A	Portable RF/Microwave Power Meter	155
1038-H/V	Network Analyzer (Scalar)	150
1038-N10	Network Analyzer (Scalar)	148
1038-NS20	Microwave Network Measurement System (Scalar)	144
1045/01	RF/Microwave Power Meter	155
1062	Economical 400 MHz Sweeper	100
1067	Economical 400 MHz Sweep	100
1067-522	Economical 500 MHz Sweeper	100
1076	RF Sweep Comparator	112
1077	RF Sweep Comparator	112
1080	1000 MHz Single Band Sweeper	102,112
1081	1000 MHz Single Band Sweeper	102
1488A-12	GPIB Converter for Model 5100	95

Model Number Index (Cont.)

NEW **New products identified by bold type.**

Model	Description	Page
1488A-13	GPIB Converter for Model 816	83
1801C	VHF/UHF Sweep/Signal Generator	104
1901C	X-Y Display Scope	108,112
2001	1400 MHz Sweeper	106
2002B	2500 MHz Sweeper	138
2005	4500 MHz Sweeper	138
3000	520 MHz Signal Generator	114
3006	520 MHz Signal Generator	116
3007	Signal Generator/Deviation Meter	118
3510B	1 to 1040 MHz Signal Generator	120
3520	1 to 2080 MHz Signal Generator	122
4501	Group Delay Analyzer	110
4602	Group Delay Analyzer	110
5001	Turret Attenuator	127
5010	Turret Attenuator	127
5035	Turret Attenuator	127
5070	Turret Attenuator	127
5080	80 dB Step Attenuator	127
5080.1	80 dB Step Attenuator	127
5100	DC to 3 MHz Programmable Frequency Synthesizer	94
5110	DC to 3 MHz Programmable Frequency Synthesizer	94
5120A	0.1 to 160 MHz Programmable Frequency Synthesizer	96
5130A	0.1 to 160 MHz Programmable Frequency Synthesizer	96
5135A	0.1 to 160 MHz Programmable Frequency Synthesizer	96
5155A	100 kHz to 1 GHz Programmable Frequency Synthesizer	98
5156A	100 kHz to 1 GHz Remote Programmable Frequency Synthesizer	98
5201	Tunable Bandpass Filter	126
5202	Tunable Bandpass Filter	126
5203	Tunable Bandpass Filter	126
5204	Tunable Bandpass Filter	126
5205	Tunable Bandpass Filter	126
5206	Tunable Bandpass Filter	126
6000	Instrumentation Controller	156
6000A	**Instrumentation Controller**	**156**
6006	20 Mbyte Hard Disk Drive	160
6008	Floppy Disk Drive, 8 inch Dual	160
6010	80 Column Printer with GPIB Interface	159
6014	External 14 In. Monitor	160
6020	Assembly Language System	159
6021	Pascal Language System	143
6030	HP85 BASIC to 6000 BASIC	159
6035	HP9835 BASIC to 6000 BASIC	159
6036	HP9826 BASIC to 6000 BASIC	159
6040	Math Library	159
6041	Statistics I Library	159
6042	Statistics II Library	159
6043	Fast Fourier Transform	159
7501	Turret Attenuator	127
7510	Turret Attenuator	127
7535	Turret Attenuator	127
7570	Turret Attenuator	127
7580	80 dB Step Attenuator	127
7580.1	80 dB Step Attenuator	127
7580.1A	80 dB Step Attenuator	127
8501	**One Channel 30 MHz to 40 GHz RF Peak Power Meter**	**152**
8502	**Two Channel 30 MHz to 40 GHz RF Peak Power Meter**	**152**

Product Index

Analyzer, Group Delay 110
Analyzer, RF Scalar System 112
Analyzer System, Microwave Network 144,148
Analyzer System, Microwave Swept Network 150
Arbitrary Waveform Function Generator 50,46
Assembly Language System 159
Attenuator, Turret 127
Attenuator, 80 dB Step 127
Bridge, Return Loss 112
Control Panel, Signal Switcher 166
Controller, Instrumentation 156
Computer, Instrumentation 156
Detector, RF 126
Disk Drive, Floppy 160
Disk Drive, Hard 160
Filter, Analog, Dual HI/LO, Variable 86,88
Filter, Analog, Programmable, Multi-Channel 82
Filter, Brickwall, Multi-Channel 80
Filter, Brickwall, Programmable 84
Filter, Tunable Bandpass 126
Fourier Transform, Fast 159
Frequency Synthesizer, DC to 3 MHz 94
Frequency Synthesizer, 0.1 to 160 MHz 96
Frequency Synthesizer, 100 kHz to 1 GHz 98
Function Generator, 2 MHz 18
Function Generator, 4 MHz 24
Function Generator, 12 MHz 36
Function Generator, 20 MHz 58
Function Generator, AM/FM/PM, 20 MHz 56
Function Generator, Stabilized, 11 MHz 30
Function Generator, Synthesized, ... 22, 34, 44, 68
GPIB Converter 83,95
Group Delay Analyzer 110
Impedance Adapter, Audio Output . . 90
Measurement System, Microwave Network 144
Measurement System, Microwave Swept Frequency 150
Modulation Generator 56,62
Monitor, External, 14-Inch Screen . 160
Noise Generator 20
Oscilloscope, X-Y Display 108,112
Pascal Language System 159
Phase Lock Generator, 5 MHz 28
Power Meter, Peak Microwave 154,152
Power Meter, RF 155
Printer, 80 Column with GPIB Interface 159
Pulse Generator, 50 MHz 72,74,76
Pulse/Function Generator, 4 MHz 26
Pulse/Function Generator, 12 MHz 38
Pulse/Function Generator, 20 MHz 54,60
Pulse/Function Generator, 50 MHz 66
Rack Mounting 172
RF Source Modules for NS20 Systems 147
Scalar Analyzer System, RF 112
Signal Generator/Deviation Meter 118
Signal Generator, 1 to 1040 MHz . . 120
Signal Generator, 1 to 2080 MHz . . 122
Signal Generator, 520 MHz . . . 114,116
Signal Generator, 3.7-7.6 GHz 130
Signal Generator, 7-11 GHz . . . 130,132
Signal Generator, 7-12.4 GHz 130,133
Signal Generators, Micro Source, 1-18 GHz 134
Slides, Rack 172
Software, Computer 159
Sweep Comparator 112
Sweep/Function Generator, 4 MHz 24
Sweep Generator, 30 MHz 64
Sweep Generator, 400 MHz 100
Sweep Generator, 500 MHz 100
Sweep Generator, 1400 MHz 106
Sweep Generator, 2500 MHz 138
Sweep Generator, 4500 MHz 138
Sweep Generators, Micro Sweep, 1-18 GHz 140
Sweep Generator, Single Band, 1000 MHz 102
Sweep Generator, Stabilized, 11 MHz 34
Sweep/Function Generator, 12 MHz 40
Sweep/Modulation Generator, 20 MHz 56,62
Sweep/Signal Generator, VHF/UHF 104
Switcher Module, 10 Channel, 200 MHz 166
Switcher Module, 10 Channel, 500 MHz 167
Switcher Module, 10 Channel, Low Level 169
Switcher Module, Attenuator, 250 MHz 170
Switcher Module, Dual 1 of 4, 1.5 GHz 170
Switcher Module, General Purpose, 16 Channel Driver 168
Switcher Module, High Power 168
Switcher Module, Matrix, 250 MHz 167
Switcher Module, Microwave Switch, DC to 18 GHz 169
Switcher Module, Microwave Switch, DC to 26.5 GHz 171
Switcher Module, Universal Breadboard 171
Switcher, Programmable Signal . . . 163
Synthesizer, Frequency DC to 3 MHz 94
Synthesizer, Frequency 0.1 to 160 MHz 96
Synthesizer, Frequency 100 kHz to 1 GHz 98
Synthesizer/Function Generator 34,44,22,68
Synthesizer, Variable Phase 12
Transform, Fast Fourier 159
Variable Phase Synthesizer 12
VCG/Noise Generator 20
Waveform Synthesizer, Programmable 68

Order, Warranty & Service Information

Placing Your Order
Domestic: Wavetek has sales representatives in your area to assist with your equipment selection, prices, delivery and special requirement information. Actual shipment and invoicing will be made by the applicable factory. Your orders should be addressed to **Wavetek, c/o your sales representative.**

Export: Exclusive distributors/representatives are maintained in most countries to handle your purchasing needs and any after-purchase service requirements. Wavetek Electronics GmbH is available in Munich, West Germany to support all European, African and Middle-Eastern customers and distributors.

GSA Contracts
Many Wavetek products are sold under GSA contracts. If you are authorized to purchase under the GSA, contact your local Wavetek Representative or the applicable Wavetek factory directly.

Terms of Sale
Domestic: Standard terms are net 30 days with established credit.

Export: Payment and terms for orders placed from outside the USA are confirmed irrevocable letters of credit or cash in advance or other terms that may have been arranged in advance.

Wavetek reserves the right to change prices. Prices prevailing at the time an order is received will apply.

All prices are FOB factory and apply to domestic USA customers for USA purchases only. If you require a written quote, please contact the appropriate office as you would to place your order. All proforma invoices for international purchases must be supplied by Wavetek.

Certification
Wavetek's Quality Assurance program satisfies the requirements of MIL-I-45208A, MIL-C-45662A and good manufacturing practices. Wavetek's calibration accuracy is traceable to the National Bureau of Standards.

Certificates of Conformance/Compliance and Calibration/Traceability are available upon request at time of purchase.

Shipping Methods
Domestic: Orders are shipped, FOB, factory direct from Wavetek via UPS or common carrier depending on size and weight restrictions except for GSA. Air freight is available upon request.

Refer to the specifications page for the factory/FOB source of individual instruments.

Export: Shipments to destinations outside the USA are made via air freight forwarders from the individual factories. Many international distributors may have the instruments you require in stock to save you delivery time.

Product Changes
Wavetek, in a continuing effort to offer excellent products at a fair value, reserves the right to change specifications and models without notice.

Warranty
Wavetek's product line has gained the reputation of excelling in both reliability and performance. The company's reputation is reflected by the following Warranty:

Wavetek warrants that all products manufactured by Wavetek conform to published Wavetek specifications and are free from defects in materials and workmanship for a period of one (1) year from the date of delivery when used under normal operating conditions and within the service conditions for which they were furnished.

The obligation of Wavetek arising from a Warranty claim shall be limited to repairing, or at its option, replacing without charge, any product which in Wavetek's sole opinion proves to be defective within the scope of the Warranty. In the event Wavetek is not able to modify, repair or replace non-conforming defective parts or components to a condition as warrantied within a reasonable time after receipt thereof, Buyers shall be credited for their value at the original purchase price.

Wavetek must be notified in writing of the defect or nonconformity within the Warranty period and the affected product returned to Wavetek's factory or to an authorized service center within (30) days after discovery of such defect or nonconformity.

For product warranties requiring return to Wavetek, products must be returned to a service facility designated by Wavetek. Buyer shall prepay shipping charges, taxes, duties and insurance for products returned to Wavetek for warranty service. Except for products returned to Buyer from another country, Wavetek shall pay for return of products to Buyer.

Wavetek shall have no responsibility hereunder for any defect or damage caused by improper storage, improper installation, unauthorized modification, misuse, neglect, inadequate maintenance, accident or for any product which has been repaired or altered by anyone other than Wavetek or its authorized representative and not in accordance with instructions furnished by Wavetek.

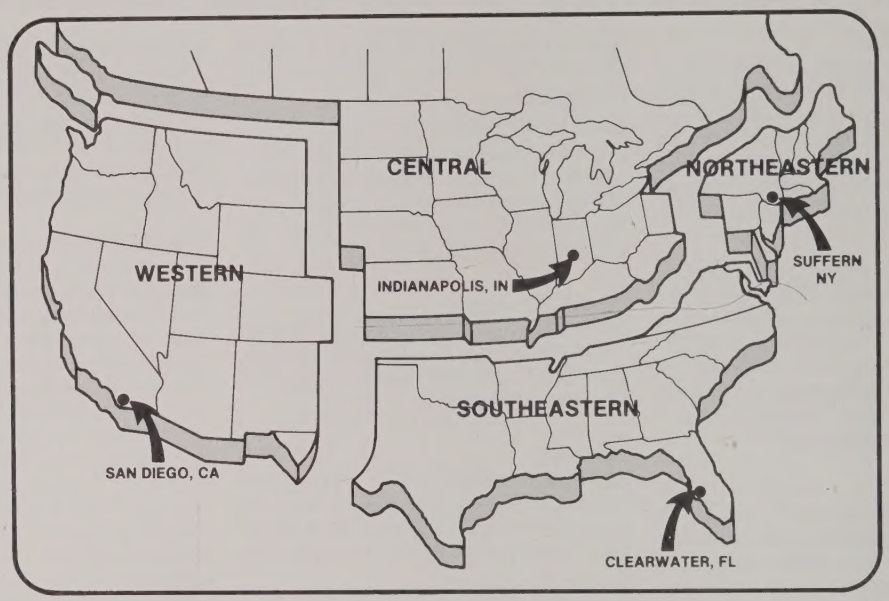
Exclusion of Other Warranties
The Warranty described above is Buyer's sole and exclusive remedy and no other warranty, whether written or oral, is expressed or implied. Wavetek specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. No statement, representation, agreement, or understanding, oral or written, made by an agent, distributor, representative, or employee of Wavetek, which is not contained in the foregoing Warranty will be binding upon Wavetek, unless made in writing and executed by an authorized Wavetek employee. **Under no circumstances shall Wavetek be liable for any direct, indirect, special, incidental, or consequential damages, expenses, losses or delays (including loss of profits) based on contract, tort, or any other legal theory.**

Service and Repair
Should a malfunction occur with any Wavetek instrument, contact your nearest Wavetek representative. An apparent malfunction may be correctable over the phone. If further aid is required, you will be directed to the nearest authorized service center or factory. *Please obtain authorization before attempting to send the instrument to the factory.* If it does become necessary to return an instrument, *any symptoms, along with your name and phone number,* should be written on a card and taped to the top of the instrument. *The instrument should be properly packaged and shipped prepaid.*

Instruments not covered under warranty will be evaluated and upon request you will be supplied with a formal quote. Repair will begin when authorization is received in the form of a purchase order. Wavetek gives a 90 day guarantee on all out-of-warranty repairs.

Addresses
Addresses for Wavetek offices are given on pages 6 and 7. Wavetek Representatives and their addresses are given on pages 174 and 176.

Sales



Wavetek sells its products through a world wide network of representatives and distributors.

A list of these representatives/distributors can be found on the last four pages of this catalog (pages 174 to 177). They are listed by state or country so you can quickly locate the Wavetek Representative/Distributor servicing your area. Please give them a call. They can help you with your questions, supply additional information or assist you in making the proper selection for your specific application needs.

An on-sight demonstration of Wavetek products can be arranged through your local Wavetek Representative.

Additionally, Wavetek supports its markets through its Area and Regional Sales Offices. These offices can also answer your questions and put you in touch with your local Representative/Distributor.

U.S. AREA SALES OFFICES

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ASIA, PACIFIC & SOUTH AMERICA SALES OFFICE

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Operations

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Wavetek is a leading manufacturer of electronic test and measurement equipment. Wavetek products are sold throughout the world to customers engaged in communications, education, design, development, maintenance, production and research activities for laboratory and industrial applications.

INDIANA DIVISION

WAVETEK INDIANA, INC.
5808 Churchman
P.O. Box 190
Beech Grove, IN 46107
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Toll Free: (800) 431-9191
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Fax: (317) 788-5999 (For T&M)
Fax: (317) 828-7677 (For CATV)

Wavetek Indiana produces a line of precision test instruments that includes signal and sweep generators, display oscilloscopes, group delay analyzer and CATV test equipment. Also produced are a wide variety of RF and microwave components. These products are used extensively in a variety of applications in communications, aerospace, government, education and medicine.

- Signal Generators
- Sweep Generators
- CATV Test Equipment
- Signal Level Meters
- Display Oscilloscopes
- Microwave Components
- Group Delay Analyzers

PACIFIC MEASUREMENTS DIVISION

WAVETEK PACIFIC MEASUREMENTS, INC.
488 Tasman Drive
Sunnyvale, CA 94089
Phone: (408) 734-5780
Toll Free: (800) 227-WPMI
TWX: (910) 339-9273
Fax: (408) 747-1265

Wavetek Pacific Measurements produces RF and microwave power meters and scalar network analyzer systems for both benchtop and ATE applications. The products are used in both military and commercial applications where highly accurate microwave measurements are essential.

- Portable RF Power Meters
- Systems RF Power Meters
- RF Peak Power Meters
- Scalar Network Analyzers
- Network Analyzer Systems

SAN DIEGO DIVISION

WAVETEK SAN DIEGO, INC.
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Wavetek San Diego produces a full line of signal sources which includes products ranging from high quality, basic instrumentation, to precision microprocessor controlled instruments for the most demanding laboratory and automated applications.

- Function Generators
- Pulse Generators
- Frequency Synthesizers
- Arbitrary Waveform Generators
- Signal Processing Filters
- Microwave Generators
- Instrumentation Controller
- Signal Switching Systems
- Variable Phase Synthesizer

EUROPEAN SALES & MANUFACTURING HEADQUARTERS

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Wavetek Europe serves as the sales and service center for all Wavetek Divisions covering the European, Middle East and African marketplaces. Wavetek's European manufacturing facilities produces products designed and developed in both Europe and the United States.

GERMAN SALES OFFICE

WAVETEK ELECTRONICS GMBH
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Federal Republic of Germany
Tel: (089) 461 090
Telex: 521-2296 + WVTK D
Fax: (089) 463 223

Wavetek products are sold directly into the Federal Republic of Germany marketplace through our German sales office, which provides sales and maintenance services for all Wavetek products and instruments from a select few other manufacturers.

UNITED KINGDOM SALES OFFICE

WAVETEK ELECTRONICS LTD.
Tag Lane
Hare Hatch, Reading, Berks RG10 9 LT.
United Kingdom
Tel: Wargrave (073522) 4121
Telex: 849301 + WVTK G
Fax: (073522) 4233

Wavetek products are sold directly into the UK marketplace through our Reading office. The staff is highly skilled in providing sales and maintenance service for all Wavetek product lines as well as representing other instrument manufacturers in the test and measurement field.

FUNCTION GENERATOR SELECTION GUIDE

Top Frequency (MHz)	*	2			4			5	11		12	20						30	50
MODEL	75	132	171	20	182A	188	187	186	21	22	23	143	145	148A	190	191	193	164	166
Low Frequency (Hz)	2.4μ	0.2	0.1	2m	4m			0.1m			10m	0.1m		0.2m	2m			30μ	.1m
Frequency Accuracy (± % F.S.)	.015	2	.005	5					0.09		.005	3		2	3			2	
Int Linear Sweep						•				•				•			•	•	•
Int Log Sweep						•				•									•
Int Step Sweep																		•	
Trigger & Gate	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
AM as well as FM								•			•			•			•		•
Phase Modulation														•					
Phase Lock								•											
Synthesizer Accuracy			•								•								
Arbitrary Waveforms	•																		
Variable S/N Ratio		•																	
Variable Symmetry								•				•		•	•	•	•	•	
Variable Rise/Fall																		•	•
Start/Stop Control†	•											•	•	•					
Pulse Generator††							•						•			•			•
Digital Display	•		•						•	•	•								
Haverwave	•								•			•	•	•					•
Hold/Continue	•								•										•
Output Protection	•			•					•	•	•								
Battery Power				•															
GPIB & RS 232-C Programming***	**										**								
Catalog Page	50	20	22	18	24	24	26	28	30	32	34	54	54	56	58	60	62	64	66

NOTE: All models feature External Voltage Control (VCG) and DC Offset Control

*See detailed specifications
**Option
***Also see Programmable Generator Selection Guide
†Start/Stop at selected waveform phase angle
††Also see Pulse Generator Selection Guide

GPIB PROGRAMMABLE FUNCTION, PULSE AND SYNTHESIZED GENERATORS SELECTION GUIDE

High Frequency (MHz)	•	•	2	12						13	50	
MODELS	75	175	650	23	270	271	273	275	278	172B	178	859
Low Frequency (Hz)	2.4μ	3.9μ	100μ	10m	0.01					0.1m	1μ	0 5
AM/FM/ΦM			AM/FM/ΦM	AM/FM	FM						AM/ΦM	
Maximum Voltage Output (Peak-to-Peak)	20		50	20						30	20	
Trigger and Gate	•	•	•	•	•	•	•	•	•	•	•	•
Stored Settings	•		•		•	•	•	•	•	•	•	•
Variable Phase Control	•		•								•	
Manual Control	•	•	•	•	•	•	•	•	•	Opt	•	•
Symmetry Control		•	•							•		
Arbitrary Waveforms	•	•						•				
Pulse						•					•	•
Synthesizer			•	•					•	Opt	•	
Burst	•		•		Opt	•	•	•	•			
Sweep			•				•				•	
Internal Trigger			•				•	•	•			
Frequency Digits Res.	4		10	4	3				5	5½ Opt	8	3
Amplitude Digits Res.	3		5	3						3½		3
Phase Res. (m°)	44	180	10					44			10	
Vdc/Offset Digits Res.	3		5	3								
MATE Interface			Opt					Opt			Opt	Opt
GPIB	Opt	•	•	Opt	•	•	•	•	•	•	•	•
RS 232-C Option	•			•								
Automatic Calibration and Performance Verification Aid			•		•	•	•	•	•			
Output Protection	•		•	•	•	•	•	•	•	•		
Featured on Catalog Page	50	••	12	34	36	38	40	46	44	••	68	76

*See Specifications.
**Consult Wavetek representative or factory for details.

PULSE GENERATOR SELECTION GUIDE

Top Frequency (MHz)	4	12		20		50			
MODEL	**187**	**271**	**278**	**145**	**191**	**166**	**801**	**802**	**859**
Low Frequency (Hz)	0.004	0.01	0.01	0.0001	0.002	0.0001	5	5	0.5
Delay Control	•	•		•	•		•	•	•
Minimum Rise Time* (ns)	<50	<15	<15	<20	<15	<7	<7	<5	<5
Transition Control						•	•		•
Double Pulse	•	•		•	•		•	•	•
Counted Pulse Burst		•	•						•
External Width Mode		•	•			•	•	•	•
Internal Load Control								•	
Auxiliary Outputs (ECL) (See Note Below)				•			•		
Trigger Level Control		•	•	•	•	•	•		•
Trigger on Either Edge		•	•				•		•
Trigger Burst		•	•		•		•		•
Amplitude Modulation						•			
Frequency Modulation	•	•	•	•	•	•			
Waveforms other than Pulse	•	•	•	•	•	•			
Internal Sweep						•			
GPIB Programmable		•	•						•
Catalog Page	26	38	44	54	60	66	72	74	76

NOTE: All models feature Period and Width Control, Complement Pulses and TTL Auxiliary Outputs.

FILTER SELECTION GUIDE

Type	Bench Top				Programmable Bench Top			Multi-Channel Programmable	
MODEL	**432**	**442**	**452**	**852**	**751A**	**752A**	**753A**	**716**	**816**
Frequency Lower (Hz)	1	10	0.1*	0.1*	1	1	1	1	0.1,1,10
Upper (kHz)	110	1100	111	111	100	100	100	100	1.5,15, 150
Resolution (Digits)	2	2	3	3	2	2	2	2	1
Rolloff Rate, per Channel (dB/Octave)	24	24	24	48	115	115	115	115	48
Filter Function Low Pass	•	•	•	•		•	•	•	•
High Pass	•	•	•	•			•	•	•
Bandpass	•	•	•	•	•		•	•	•
Band Reject	•	•	•	•			•	•	•
Notch	•	•	•	•			•	•	
No. of Channels	2	2	2	2	1	2	2	16	16
Broadband Noise (rms)	250μV	500μV	100μV	200μV	10μV	10μV	10μV	10μV	710μV
Max. Attenuation, (dB)	80	80	90	90	80	80	80	80	80
Programming Front Panel	•	•	•	•	•	•	•	•	•
TTL					Option	Option	Option		Standard
GPIB Programming					Option	Option	Option	Standard	Option‡
Featured on Catalog Page	88	88	86	86	84	84	84	80	82

*0.01 Hz with Option 01.
‡Separate Instrument.

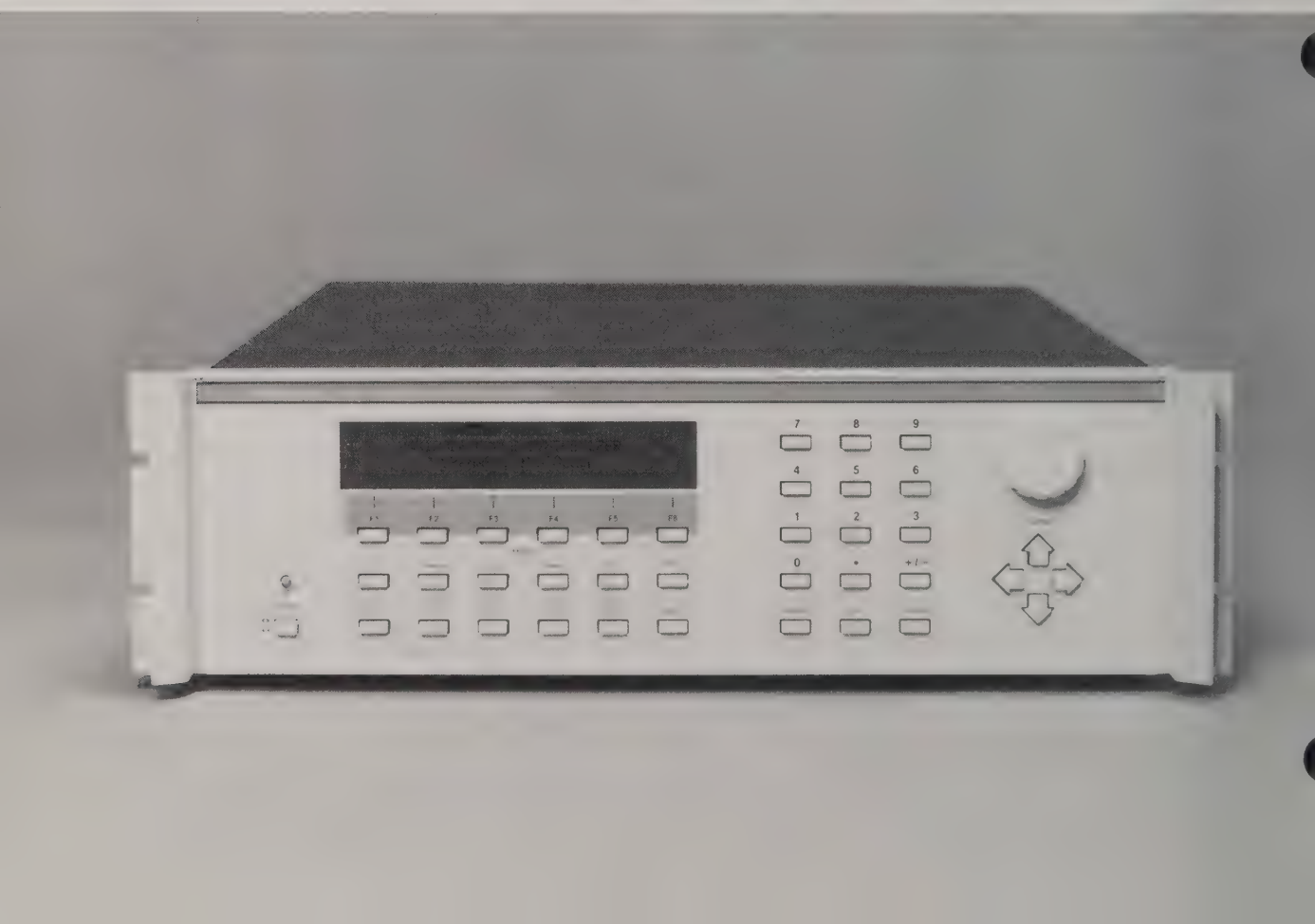
Precision 2 MHz Variable Phase Synthesizer

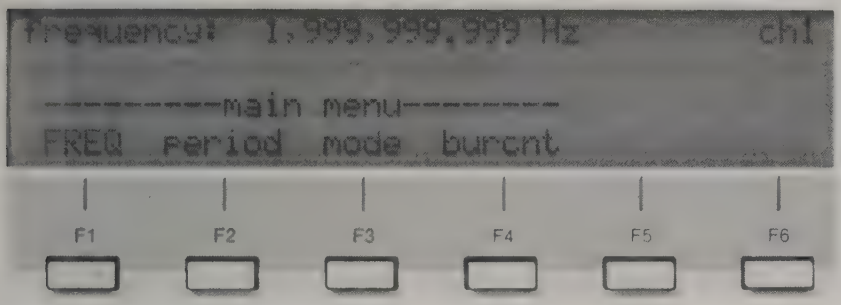
- **0.005 Phase Accuracy at Low Frequencies**
- **2 or 4 Channels in a 5¼ in. High, 19 in. Unit**
- **Up to 40 Channels Cascadeable**
- **Flexible Phase and Frequency Sweep Modes**
- **High Accuracy Output up to 50 Vp-p**

Capabilities
Model 650 represents the ultimate in variable phase generator design. The instrument combines superb phase accuracy, synthesizer frequency accuracy, high output amplitude capability and excellent stability. The standard model has two channels which can be expanded to four. As many as ten Model 650's can be cascaded to obtain 40 channels of phase controlled signals. In addition to sine waves, each output can be independently programmed to square, triangle and variable duty-cycle square and ramp waveforms.

Accuracies
Amplitude accuracy is ±0.5% below 100 kHz and frequency accuracy is 5 ppm. Frequency resolution is an incredible 10 digits or 100 μHz, and even at 50 Vp-p the output voltage resolution is 1 mV.

The unit is fully programmable via GPIB (IEEE-488). Many operating and sweep modes make it suitable for a multitude of applications related to analog and digital design work, phase meter calibration, phased arrays, avionics, industrial robotics and communications.





Menu Driven Display in Plain English Makes the 650 Easy to Use

Specifications

WAVEFORMS (FUNCTIONS)

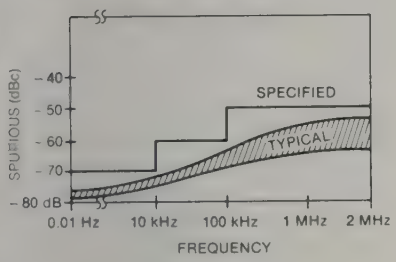
Programmable sine, square, triangle, ramp, dc and variable-duty-cycle-square and ramp.

Range

Sine, Square: 0.1 mHz to 2 MHz.
Ramp, Triangle: 0.1 mHz to 200 kHz.
Resolution: 10 digits or 0.1 mHz.
Accuracy: ± 5 ppm.
Stability: ± 3 ppm.

Waveform Quality

Sine Wave:



Spurious Nose vs. Frequency

Frequency	Spurious	Harmonics
⩽10kHz	⩽ – 70dBc	⩽ – 60dBc
⩽100kHz	⩽ – 60dBc	⩽ – 50dBc
⩽2MHz	⩽ – 50dBc	⩽ – 40dBc

Square Wave:
Rise/Fall Time: ⩽75ns.
Aberrations: ⩽5% Vp-p.
Duty Cycle: 20 to 80% ± 1%.

Triangle/Ramp:
Linearity: ⩾99% ⩽10kHz; ⩾90% <200kHz.
Duty Cycle: 0 to 100% ± 1%.

PRIMARY MODES

Continuous
All channels run continuously.

Triggered
All channels are quiescent until triggered by an external, internal, GPIB or front panel trigger upon which one signal cycle is output.

Gated
As triggered mode except output signals will be present as long as the gate signal is present.

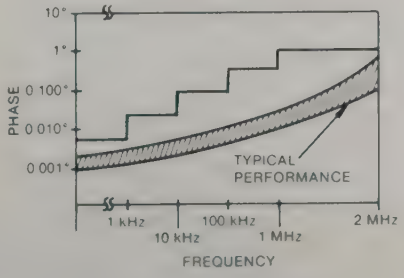
Burst
All channels are quiescent until triggered, upon which a pre-programmed number of signal cycles (burst count) is output.
Burst Count: 1 to 65535.

SECONDARY MODES

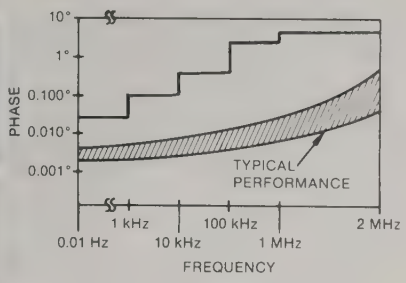
Phase Shift
Phase of each channel can be programmed with respect to the main generator. Channel No. 1 usually serves as a reference channel with the other channels having variable phase. Phase shift applies to all waveforms programmed for the particular channel.
Phase Resolution: 10 millidegrees.
Phase Accuracy: For compared channels of equal amplitude and compared channels of unequal amplitude with amplitude ratios up to 10.

Frequency	Sine Wave Phase Accuracy For Equal Ampl Angle	Unequal Ampl Angle
<1 kHz*	0.005°	0.020°
<10 kHz	0.030°	0.100°
<100 kHz	0.100°	0.500°
<1 MHz	0.500°	2.000°
<2 MHz	1.000°	5.000°

*At phase settings equal to 360/n where n is an integer in the range 1 – 8192.



Phase Accuracy for Amplitude Ratio 1:1



Phase Accuracy for Amplitude Ratio 1:10

Phase Delay
Phase offset of a channel may be programmed in delay time rather than in degrees. Model 650 will automatically compute phase in degrees (for any frequency) for a given delay.
Delay Resolution: 3 digits.
Delay Range: – 2 to + 2ms.

Modulation
There are six different amplitude, frequency and phase modulation modes used in combination with the primary modes. Refer to the **Modulation Modes** section for details.

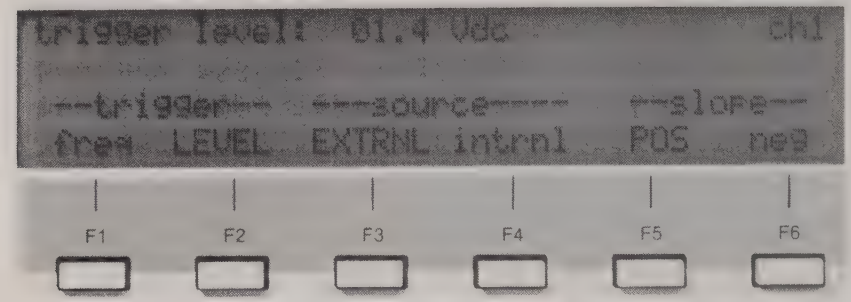
Sweep
There are 29 different sweep modes covering phase sweeps, frequency sweeps and combined phase/frequency sweeps in combination with the primary modes. Details on sweep modes are given in the Sweep Generator section.

Phaselock
In phaselock mode, Model 650 will lock onto an external reference in the frequency range of 40Hz to 2 MHz. The main generator frequency will then be kept to the initial reference frequency. If the reference frequency changes in excess of ± 10%, Model 650 will reset its main generator frequency to the new frequency.
Phaselock Range: 40Hz to 2MHz.
Initial Lock Time: ⩽4 sec.
Re-lock Time: 100 periods + 100ms.

Delta Frequency
One channel at a time can run at a frequency that differs up to ± 1000 Hz from the main frequency. For example, the main generator and Ch1 can be run at a given frequency, Ch2 can run at a given frequency ratio, while Ch3 can run at yet another ratio and finally Ch4 can be operated at (N x main frequency) ± (N x delta frequency) whereas N is a ratio in the range 1 to 99 and delta frequency is a frequency in the range 0.1 mHz to 1000 Hz.
Range: – 1000 to + 1000 Hz.
Resolution: 3 digits but max 0.1 mHz.
Accuracy: 0.1%.

TRIGGERING

The 650 can be triggered via its internal trigger generator or an external trigger



Display of Trigger Menu. Selected: External Source, Positive Slope, Trigger Level 1.4 Vdc

signal. In external trigger mode, trigger level and signal polarity are selectable.

Internal Trigger Signal

External Availability: Present at Marker Out connector in non-sweep modes.
Range: 2.5 mHz to ⩾200 kHz.
Resolution: 3 digits.
Accuracy: 0.1%.

External Trigger Signal

Frequency Range: 0 to ⩾200 kHz.
Amplitude Range: +10 to −10V.
Level Setting Resolution: 0.1V.
Level Accuracy: ±0.3V.

MODULATION

Amplitude Modulation

Range: 0 to 100%.
AM Bandwidth: 0 to 20 KHz.
Modulation Gain (VCG): 10.
AM Input Impedance: >10kΩ.
Protection: ± 50 Vdc (Momentary).

Phase Modulation

Range: Programmable 0 ± 1080°.
PM Bandwidth: 25 kHz.
Voltage Controlled Phase Modulation (VCPM): −1V to +1V for full modulation between programmed start and stop phase with 8 bit resolution.
PM Input Impedance: ⩾1MΩ.
Protection: ±50 Vdc momentary.

Frequency Modulation

Programmable start and stop frequency in range 0.1 mHz to 2 MHz.
FM Bandwidth: 20 kHz.
Voltage Controlled Frequency Modulation (VCFM): −1V to +1V for full modulation between programmed start and stop frequency values with 8 bit resolution.

Frequency Shift Keying

Asynchronous (Async FSK) and Synchronous (Sync FSK).
Max Rate of FSK: 40 kHz (25 μs per step).
Max No. of Different Frequencies in FSK Mode: 100.
Switching Time Between Frequencies: ⩽500 ns.

Phase Shift Keying

Max Rate of PSK: 65 kHz.
Phase Shift Keying Capabilities: Dual Phase Shift Keying (DPSK) and Quadrature Phase Shift Keying (QPSK) through sequenced phase sweep mode.
Max No. of Different Phase Values in PSK Mode: 100.

Pulse Position Modulation

Max Rate of PPM: 65 kHz.
Max No. of Different PPM Values: 100.

CHANNEL OUTPUTS

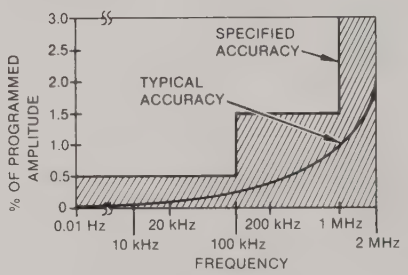
Each channel can individually be programmed for the following parameters.

Function

Sine, square, triangle, dc, ramp or programmable duty cycle square or ramp.

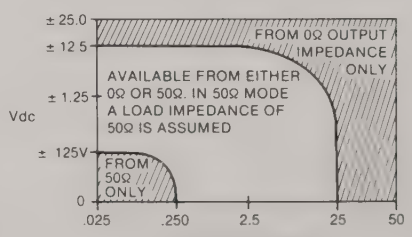
Amplitude

Range, Resolution and Accuracy: Refer to table 1. Range is restricted by dc offset as shown in the second diagram.



NOTES: 1. All accuracies ±2 mV.
2. 0Ω output impedance into high impedance load or 50Ω output impedance into 50Ω, 0.001% accurate load
3 Triangle and ramp to 200 kHz only

Amplitude Accuracy vs. Frequency



NOTES: 1. Maximum output current in 0Ω modes ±0.5A
2 Output voltage ⩽250 mVp-p or ±125 mVdc are available from 50Ω impedance only

Available and Permissible DC Offset and AC Amplitude Combinations.

Offset

Range, Resolution and Accuracy: Refer to table 2. Range is restricted by ac amplitude as shown in the diagram.

DC

Maximum Range: ±12.5mV to ±25V.
Range, Resolution and Accuracy: Refer to table 3.

Frequency Ratio

Each channel can be set at a ratio of 1 to 99 times the main frequency.

Output Impedance

Output impedance can be programmed to be either 0Ω or 50Ω or the output can be turned off (output relay open). In the 50Ω mode a 50Ω termination is assumed.

SWEEP

The 29 sweep modes allow phase sweep, frequency sweep, synchronous and asynchronous FSK modes and combinations of phase and frequency sweeps. Furthermore, phase and frequency can be swept in a linear, log, sine or random fashion. Sweep time and Start-Stop Phase/Frequency are programmable with synthesizer accuracy and resolution. Indexed phase and/or frequency sweep modes are available which allow the user to preprogram up to 100 steps of frequency and phase values. The whole or partial sequence can then be stepped through under internal sweep generator or external trigger control. In addition, sweep modes can be continuous, triggered, triggered with reset, hold and reverse, etc. Finally, a sweep can be interrupted by an external, GPIB or front panel hold command while an operator may monitor phase or frequency via the front panel display. A waveform hold allows external, GPIB, or front panel "freezing" of a waveform at its current dc voltage value. To allow very high sweep rates on the one hand while providing optimum accuracy at the other, a sweep can be compensated or uncompensated. In the compensated sweep mode, extreme amplitude flatness and very high phase accuracy are maintained by applying correction values previously stored in the Autocal (refer to **Calibration**) database. In the uncompensated mode, these correction values are ignored and in their place very high sweep rates are provided. Because of the enormous number of sweep mode, time, trigger and compensation combinations, it is not practical to specify all possibilities. The following data and illustrations allow the user to derive timing and/or resolution parameters where necessary. Detailed information is available in the applications manual or from Wavetek's Applications Engineering Department.

Table 1. Amplitude Range, Resolution and Accuracy

Output Impedance	Range (Vp-p)	Resolution	Accuracy		
			⩽100 kHz	⩽1 MHz	⩽2MHz
0Ω	2.5 – 50	1 mV	±0.5% ±2 mV (typ: ±0.2% ±1 mV)	±1.5% ±2 mV (typ: ±0.3% ±1 mV)	±3% ±2mV (typ ±1.5% ±1 mV)
50Ω	0.025 – 0.25	10μV			
	0.25 – 2.5	100μV			
	2.5 – 25	1 mV			

Table 2. Offset Range, Resolution and Accuracy

Output Impedance	Range (Vp-p)	Resolution	Accuracy
0Ω	±25	1 mV	0.5% ± 30mV
50Ω	±12.5	1 mV	0.5% ± 20mV
	±1.25	0.1 mV	0.5% ± 10mV
	±0.125	10μV	0.5% ± 5mV (typ: 0.1% ± 3mV)

Table 3. DC Range, Resolution and Accuracy

Output Impedance	Range (Vp-p)	Resolution	Accuracy
0Ω	±25V	1 mV	0.3% ± 10mV
50Ω	±12.5V	1 mV	0.3% ± 5mV
	±1.25V	0.1 mV	0.3% ± 2mV
	±0.125V	10μV	0.3% ± 1mV

Frequency Sweep

Modes:

1:Continuous with Reset.
2:Continuous with Reverse.
3:Triggered with Reset.
4:Triggered with Reverse.
5:Triggered with Hold and Reset.
6:Triggered with Hold and Reverse.
7:Synchronous FSK.
8:Asynchronous FSK.
9:Externally Triggered Sequence.
10:Continuous (Looping) Sequence.
11:Stepped Sequence on Trigger.
12:External FM.

Range: 0.1 mHz to 2 MHz.
Resolution: 10 digits but max 0.1 mHz.
Accuracy: 5ppm ± 10 μHz.
Sequenced Sweeps (Modes 9, 10, 11): No. of Programmable Steps (Index): 1 to 100.
Frequency Switching Time: ⩽500 ns.
Throughput: Refer to table 4.

Phase Sweep

Modes:

13:Continuous with Reset.
14:Continuous with Reverse.
15:Triggered with Reset.
16:Triggered with Reverse.
17:Triggered with Hold and Reset.
18:Triggered with Hold and Reverse.
19:Externally Triggered Sequence.
20:Continuous (Looping) Sequence.
21:Stepped Sequence on Trigger.
22:Delta Frequency Sweep.
23:External PM (Phase Modulation).

Range: -10^6 to $+10^6$ degrees continuous.
Resolution: 10 millidegrees.
Accuracy: Refer to table.
Sequenced Sweeps (Modes 19, 20, 21): No. of Programmable Steps (Index): 1 to 100.
Phase Switching Time: ⩽500 ns.
Throughput: Refer to table 4.

Combined Frequency and Phase Sweep

Modes:

24:Combined Simultaneous. Frequency/Phase Sweep (with identical start/stop frequency for all channels, except for ratio <>1, but individually programmed start and stop phase for each channel).
25:Triggered Combined Sweeps with Hold and Reset.
26:Externally Triggered Frequency/Phase Sequence.
27:Continuous (Looping) Frequency/Phase Sequence.
28:Stepped Frequency/Phase Sequence on Trigger.
29:External Combined FM/PM.

Range, Resolution and Accuracy: Same as for Frequency Sweep and Phase Sweep.

Sequenced Sweeps (Modes 26, 27, 28): No. of Programmable Steps (Index): 1 to 100.
Switching Time: ⩽500 ns.
Throughput: Refer to table 4.

Sweep Functions

Linear: Sweep progresses linearly from programmed start to stop value.
Log: Sweep progresses in a logarithmic fashion from start to stop value.
Random: Swept parameter changes in a random pattern uniformly distributed between start and stop value.
Sine: Swept parameter (frequency, phase or both) changes in a sinusoidal pattern from start to stop value.

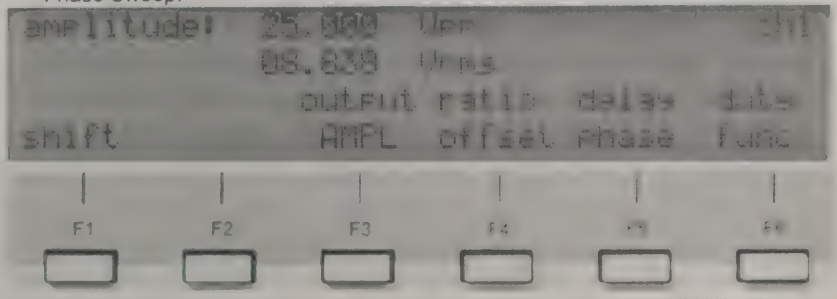
NOTE: In combined sweep modes 24 and 25, only the linear sweep function is allowed.

Table 4. Sequenced Sweeps Throughput

Sequence Mode	Compensation On	Compensation Off
9:Triggered Frequency	1.24 kHz	42 kHz
10:Continuous Frequency	1.24 kHz	38 kHz
11:Stepped Frequency	1.24 kHz	37 kHz
19:Triggered Phase	1.26 kHz	70 kHz
20:Continuous Phase	1.26 kHz	61 kHz
21:Stepped Phase	1.25 kHz	58 kHz
26:Triggered Combined	1.22 kHz	24 kHz
27:Continuous Combined	1.21 kHz	23 kHz
28:Stepped Combined	1.21 kHz	22 kHz

Sweep Times and Resolution

Sweep times and resolution greatly depend on the chosen sweep function (linear, log, sine or random), the swept parameter (frequency, phase or both) and whether or not compensation of parameters is required. The fastest sweep time of 10 ms allows for 100



Display of Channel 1's Parameter Menu. Selected: Amplitude, 25.000 Vp-p (8.838 Vrms)

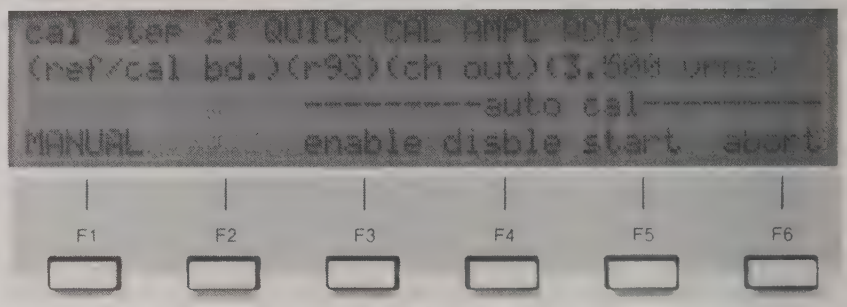
sweeps per second. In compensated mode, the fastest sweep time of 200 ms allows for 5 sweeps per second. The longest sweep time is 10^7 seconds or approximately 116 days. Compensation is generally only necessary if sweeping in frequency ranges over 100 kHz.

Sweep Time:
Range: 10 ms to 10^7 sec.
Resolution: 3 digits but max 1 ms.
Accuracy: 0.1%.
Sweep Resolution: Phase and frequency sweep resolution can be derived using the following fixed step rate table.
Fixed Step Rates: (For combinations of sweep function, swept parameter and compensation.) Refer to the following table.

Fixed Step Rates

Sweep Function	Compensation On (Steps/sec)	Compensation Off (Steps/sec)
Frequency Sweep		
Linear	1443	13,333
Log	962	4,167
Sine	1053	6,667
Random	1156	15,400
Phase Sweep		
Linear	1176	20,000
Log	1010	5,263
Sine	1064	7,143
Random	1183	22,200
Combined Frequency and Phase Sweep		
Linear	1053	6,667

Example: Assume a linear frequency sweep with a start frequency of 20 kHz, a stop frequency of 40 kHz and a sweep time of 2 seconds. In the lower frequency ranges, the compensation is not necessary therefore the uncompensated sweep is chosen, hence, a resolution of 13333 steps per second applies (Frequency Sweep, Linear Function, Compensation Off). This results in a total of 26666 steps in 2 seconds, thus a step size of (40 kHz − 20 kHz)/26666 or 0.75 Hz. Similarly, a linear phase sweep from 0° to 90° in a time of 1 second would result in phase increments of 76.5 millidegrees (rounded to 75 millidegrees) in compensated and 4.5 millidegrees (rounded to 5) in uncompensated mode. To arrive at these numbers simply divide the sweep range (90°) by the number of steps per second.



Display of Calibration Menu. Selected: Manual Calibration. Display: Step 2.

Modulation Sampling Speed

Module Mode	Compensation On	Compensation Off
12: Ext FM	1.21 kHz	20.8 kHz
23: Ext PM	1.22 kHz	25.0 kHz
29: Comb FM + PM	1.03 kHz	5.1 kHz

MASTER/SLAVE CAPABILITIES

Up to 10 Model 650's, each with up to 4 channels can be cascaded for a total of 40 phase-coherent, phase-controlled signals. Model 650 can be programmed to be either the master unit or a slave unit. Units are interconnected by three BNC cables for synchronization. Phase accuracy of slave units is equal to 2x the tolerance levels specified under Phase Accuracy.

CALIBRATION

Model 650 has internal calibration facilities that render classical calibration procedures obsolete. There are only two basic adjustments for the main generator and reference/calibration circuits, namely, the frequency of the internal 10 MHz clock and the reference voltage for the Ref/Cal circuits. Each output channel also has five adjustments. Three of the adjustments, filter flatness and two amplitude adjustments, are factory set and are not expected to undergo changes. The other two adjustments concern waveform quality and digital-to-analog conversion. With the exception of waveform quality (an adjustment that typically is required only once) the other calibration steps require no more than a high accuracy counter and DVM. The calibration procedure is stepped through via a "plain English" menu built into Model 650. Complete calibration of a four channel Model 650 can be accomplished in a matter of minutes without the need for a manual or lengthly procedure.

Once the calibration is completed, an autocal procedure is initiated which performs a self-characterization of analog circuitry within 1 minute for a two channel unit (2 minutes for a 4 channel unit). The autocal procedure requires no external measurements or additional instruments. The results of the self-characterization are stored in battery protected memory. Thus all non-linearities and differential delays of analog circuits are measured, and correction values are then computed and stored in the autocal database. These correction values are then used to obtain optimum amplitude and phase accuracy at any given frequency. Furthermore, a quick-cal feature is available. Since the autocal procedure stores its correction parameters under given ambient conditions, the data may not give optimum results if ambient temperatures change significantly. Quick-cal initiates a calibration procedure that provides optimum accuracy for the particular instrument setup; i.e., amplitude/offset/phase at a specific frequency for the prevailing ambient conditions. Within seconds, this results in optimum instrument accuracy which therefore provides consistent performance under varying conditions. The autocal correction parameters can be disabled and enabled under menu/front panel control to allow basic verification of analog circuits. If Model 650 cannot obtain the specified accuracies in either autocal or quick-cal, it will generate an error message which directs the operator to the appropriate circuits. Because autocal requires very little time (one minute for a 2 channel unit) it provides an excellent way of fast performance verification giving the operator (or the ATE system) maximum operational confidence. Because of these easy to use and fast automated calibration steps, periodic maintenance/calibration can be minimized and replaced by an "as needed" policy.

STORED SETTINGS

In addition to the stored sequence values for frequency and phase, Model 650 can store up to 25 complete instrument setups including every parameter for every channel you have seleced. Moreover the 650 also stores the current setup automatically so you may turn the unit off and return the next day, week or month and with 4 keystrokes restore any of 25 setups exactly the way you stored them.

MODEL 650 VARIABLE PHASE SYNTHESIZER

GPIB INTERFACE

Model 650 has a built-in alphabetical syntax list allowing you to start programming within minutes after unpacking the unit. The built-in "HELP" file can be printed out via a computer to give you your own syntax list. The 650 is extremely flexible in accepting GPIB commands.

For example you may program frequency by sending the "strings" shown below and the 650 will accept each of them!

Output @701:"FR 1000 EX"
Output @701:"Freq 1000 Execute"
Output @701:Frqncy 1E3 Exct"
Output @701:Frequency 1000 Execute"

Moreover, the 650 will detect programming errors. Syntax errors and parameter errors are detected, identified and categorized by the 650. The Input and SRQ buffers, each 256 characters long, can be displayed via the front panel or read by a computer. So all programing problems can be displayed, allowing easy program debugging. SRQ masks can be defined and, for example, even low battery voltage (for memory protection) will generate a service request. In short, the 650 reflects Wavetek's experience in providing easy to use, yet sophisticated programmable products.

Address Range
0 to 30 switch selectable. If enabled via rear panel switch, address can also be changed from front panel.

Subsets
SH1, AH1, TE0, L4, RL1, PP0, DC1, C0, E2.

I/O CONNECTIONS

Reference Out
Impedance: 50Ω source.
Level: TTL, <0.4V, >2.4V into 50Ω.
Fanout: 10 reference inputs.
Frequency: 10 MHz, ±5 ppm.
Protection: ±5 Vdc momentary.

Reference In
Impedance: >1kΩ ac coupled.
Level: >500 mVp-p, <50 Vdc.
Frequency: 10 MHz ± 1%.
Protection: ±50 Vdc momentary.

Trigger Input
Impedance: >5 kΩ.
Level: >500 mVp-p, <±10 Vdc.
Input: 0 to >200 kHz, 20 ns min.
Protection: ±50 Vdc momentary.

Hold Input
Impedance: <1 kΩ.
Level: TTL, active low.
Protection: ±20 Vdc momentary.
Function: selectable sweep or waveform hold.

FM/PM Input
Impedance: >1 MΩ.
Level: −1 to +1V (for full range).
Protection: ±50 Vdc.

Sampling Speed

Mode	Comp Off	Comp On
Ext FM	20 kHz	1kHz
Ext PM	25 kHz	1kHz
Ext FM/PM	5 kHz	1kHz
Resolution	8 mV	
Accuracy	± 5%	

Marker Out
Impedance: 50Ω source.
Level: TTL, <0.4V, >2.4V into 50Ω.
Output: Low when freq/phase < marker.
Protection: ±20 Vdc momentary.

2.048 V Out
Impedance: 1 kΩ.
Level: 2.048V ± 5 mV.
Output: Internal V ref cal test point.
Protection: ±50 Vdc momentary.

Phase Cal Input
The Phase Cal input is intended to externally calibrate a master/slave pair or group, or to measure phase shift through external circuits. When these measurements are not being made a relay disconnects the BNC from internal circuits.
Impedance: >300Ω.
Level: 40 Vp-p max.
Input: Slave channel for multi-unit cal.
Protection: Unprotected when calibrating, protected to ±100 Vdc otherwise.

Horiz Out
Impedance: 1 kΩ.
Level: 0 to + 10 Vdc.
Output: % of sweep.
Accuracy: ±2%.
Resolution: 40 mV.
Protection: ±50 Vdc momentary.

Phase Out*
Impedance: <50Ω.
Level: TTL.
Output: Sync pulse for master/slave configuration.
Protection: None.

Phase Clear*
Impedance: <50 ohm.
Level: TTL.
Output: Clear pulse for master/slave configuration.
Protection: None.

*Phase Out and Phase Clear are only used to lock units together in a master/slave pair or group.

Channel Func Out
Impedance: 50Ω, 0Ω selectable.
Level: −25 V to +25 V.
Output: Main function output.
Protection: Current limit at 500 mA. Withstands ±60 Vdc indefinitely.

Sync Out
Impedance: 50Ω source.
Level: TTL, <0.4, >2.4 V into 50Ω.
Output: Sync in phase with sine wave. Phase accuracy not specified.
Protection: ±20 Vdc momentary.

AM Input
Impedance: >10 kΩ.
Level: 0 to +5 V.
Input: Modulation signal up to 20 kHz BW.
Protection: ±50 Vdc momentary.

GENERAL

Environmental
Temperature Range: 0° to 50°C. 25° ± 10°C for specified performance.
Warm-up Time: 20 minutes for specified performance.
Relative Humidity: 95% at 25°C and sea level (non-condensing).
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Dimensions: 44.5 cm (17.5 in.) wide; 13.3 cm (5.3 in.) high; 53.3 cm (21 in.) deep.
Weight: 16.3 kg (36 lb).
Power: 90 to 126, 190 to 252 Vac, 48 to 66 Hz, ≤250 watts.

OPTIONS

001: Two Additional Channels
Two additional channels and the associated RAM board mount in the chassis for a total of four channels.

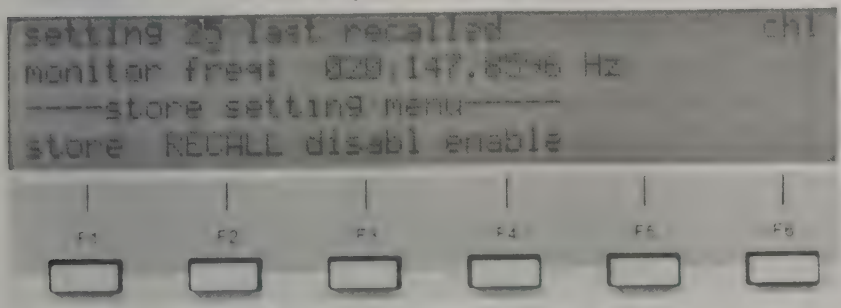
010: MATE Interface

FACTORY/FOB

San Diego, CA

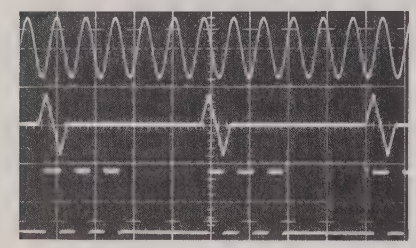
PRICE

Model 650	**$8500**
Option 001	**$3500**
Option 010	**$2400**



Display of the Stored Setting Menu. Selected: Recall Setting 25.

2 MHz Function Generator



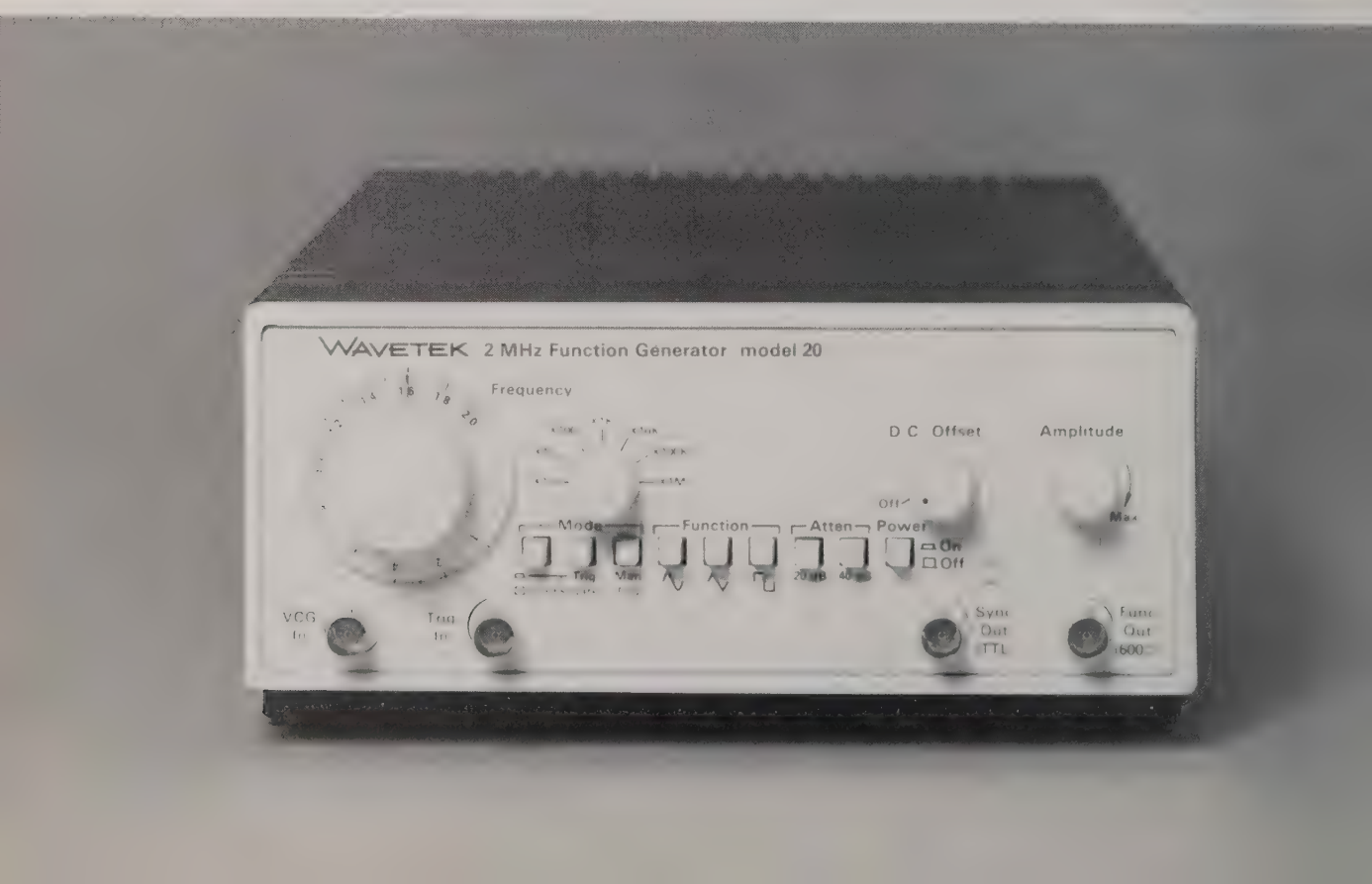
- **Multiple Power Operation**
- **0.002 Hz to 2.1 MHz Frequency Range**
- **Triggered and Gated Modes**
- **20 Volt Peak-to-Peak Output with Protection**
- **TTL Pulse Output**

Wide Frequency Range
Wavetek's Model 20 covers a wide 0.002 Hz to 2.1 MHz frequency span in seven overlapping ranges. Each multiplier setting gives you a full 1000:1 frequency range. Frequency may be set with the calibrated dial or externally modulated or swept over the three decades available per range.

Triggered and Gated Waveforms
Triggered and gated modes give the instrument additional flexibility. In triggered mode, the output is a dc baseline until a manual or external signal initiates a single cycle of the selected waveform. Gated mode is similar to triggered except that the generator produces a burst of waveform cycles for the duration of the external triggering signal.

Output Protection
Model 20 produces high level outputs to 20 volts peak-to-peak (10V p-p into 600Ω termination). Attenuation is 0 dB, −20 dB or −40 dB selectable with 20 dB variable for a total 80 dB of amplitude range. The function output is fuse protected against accidental connection to power line potentials.

Multiple Power Operation
The generator operates directly from the line using external transformer/battery charger, from an external dc or ac source, or internally from Nicad batteries. (Batteries not included.)



MODEL 20 FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine ∿, triangle ∿, square ⊓⊔ and dc.

Operational Modes
Continuous: Generator runs continuously at selected frequency.
Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one complete waveform cycle at selected frequency.
Gated: Similar to triggered mode, except output continues for duration of gate signal. Last waveform cycle started is completed.

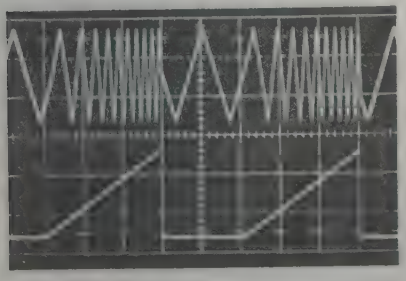
Frequency Range
0.002 Hz to 2.1 MHz in 7 overlapping ranges.

Function Output
∿, ∿, ⊓⊔, selectable and variable to 20V p-p (10V p-p into 600Ω) at Function Out BNC connector. Step and vernier attenuators provide complete amplitude control down to 2 mV p-p (1 mV p-p into 600Ω). Peak output current is 8.3 mA maximum. Source impedance is 600Ω.

DC Offset and DC Output
Waveform offset and dc output selectable and variable thru Function Output. DC output obtainable by not selecting a waveform function. DC offset control has a continuous range of ±10V (±5V into 600Ω) with a calibrated zero offset OFF position. DC offset plus signal peak limited to ±10V (±5V into 600Ω) and both attenuated proportionally by the output attenuator.

TTL Pulse Output
TTL pulse (50% duty cycle) at generator frequency. Drives up to 20 TTL loads.

VCG — Voltage Controlled Generator
BNC input, up to 1000:1 frequency change with external 0 to ±2.1V signal. Upper and lower frequencies limited to maximum and minimum of selected range.
Slew Rate: 2% of range per μs.
Linearity: ±0.5% thru X 100K range; ±2% on X 1M range.
Input Impedance: 2kΩ.



VCG Input (lower) and Generator Output

Trigger and Gate
BNC input accepts analog or TTL compatible external signal to trigger or gate the generator. Input impedance is 10kΩ shunted by 10 pF. Trigger threshold is +0.7V, generator triggers on positive-going transition and gates on during positive portion of triggering signal. External signal can have maximum repetition rate of 2 MHz and minimum pulse width of 50 ns.

FREQUENCY PRECISION

Dial Accuracy
±5% of full scale.

Time Symmetry
Square wave variation from 0.1 to 2.1 on dial less than:
±1% to 100 kHz;
±5% to 2.1 MHz.

AMPLITUDE PRECISION

Sine variation with frequency less than:
±0.2 dB on all ranges through 100 kHz, referenced to 1 kHz;
±3 dB to 2.1 MHz terminated into 600Ω and ⩽3 ft of 50Ω cable).

WAVEFORM CHARACTERISTICS

Sine Distortion
Less than:
0.5% on X 1K and X 10K ranges; 1% on X 1, X 10, X 100 and X 100K ranges, to 100 kHz.
All harmonics 25 dB below fundamental from 100 kHz to 2.1 MHz.

Triangle Linearity
Greater than 99% to 210 kHz.

Square Wave Rise and Fall Time
At function output, less than 150 ns for 10V p-p output into 600Ω termination, with ⩽3 feet of 50Ω cable.

GENERAL

Environment
Temperature Range: 23° ±5°C for specified operation, operates 0° to +50°C, −40° to +75°C (+60°C max when batteries are installed) for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 95% up to 60°C storage; operating 45% to 50°C and 75% to 25°C at sea level (non-condensing).
Vibration: 5 to 55 Hz with maximum of 2g at 55 Hz.
Shock: 30g, 11 ms half sine.

Dimensions
211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep.

Weight
3 kg (6.6 lb) net; 4 kg (8.8 lb) shipping.

Power
Wall transformer/battery charger operates the generator from 90 to 110V, 48 to 66 Hz (Opt 001); from 105 to 128V, 48 to 66 Hz (Opt 002); or from 198 to 256V, 48 to 66 Hz (Opt 003). Either transformer is less than 10 VA.

Unit will also operate from any external AC source of 10 to 18 Vrms or any external dc source of +12 to +25 Vdc. Power consumption will be less than 10W at lower input values.

User supplied rechargeable batteries, six "C" size Nicads with standard 1800 mAHr rating will deliver approximately 4 hours continuous operation from a full charge. Recharge cycle is 15 hours from full drain (indicated by flashing power indicator) with unit on or off while connected to any of the external power sources described above.

NOTE: All specifications apply for dial between 0.1 to 2, amplitude at 10 Vp-p into 600Ω termination.

OPTIONS

Model 20 must be ordered with option 001, 002 or 003. Batteries are not included.

001: Transformer/Batt Charger
90 to 110V, 48 to 66 Hz.

002: Transformer/Batt Charger
105 to 128V, 48 to 66 Hz.

003: Transformer/Batt Charger
198 to 256V, 48 to 66 Hz.

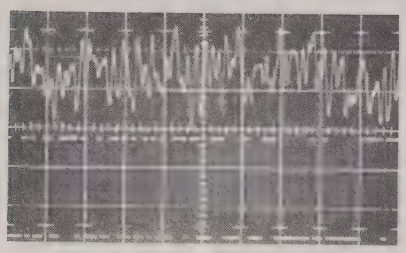
FACTORY/FOB

San Diego, CA

PRICE

Model 20	**$395**
Option 001	**N/C**
Option 002	**N/C**
Option 003	**N/C**

VCG/Noise Generator



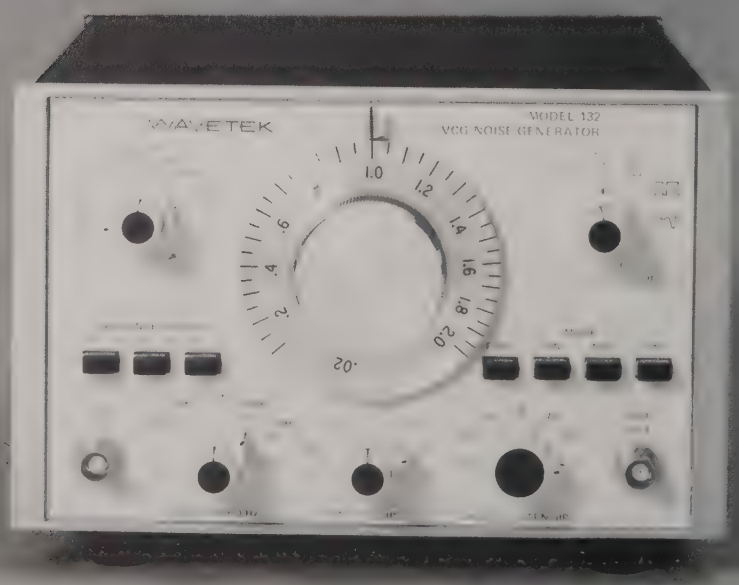
- **Pseudo-Random Analog and Digital Noise**
- **Calibrated Signal-to-Noise Ratios**
- **2 MHz Frequency Range**
- **Adjustable Incidental FM**

Pseudo-Random Analog and Digital Noise
To test your systems with random inputs, the Model 132 provides a digital pseudo-random sequence with selectable sequence length and variable clock rates up to 1.6 MHz. Analog noise is available with continuously variable bandwidth up to 100 kHz for your use as a stimulus for mechanical or vibration testing.

Variable Signal-to-Noise Ratio
The analog noise can be combined with the sine, square or triangle waveforms in the signal-to-noise or noise-to-signal mode. The ratios can be varied over a 60 dB range with calibrated front panel control. You can test modem performance, noise immunity and system performance in the presence of noise, easily and accurately.

Random FM Modulation
In the FM mode, the noise provides a variable random jitter or incidental FM to the signal frequency. Typical applications would be the testing of discriminator circuits or phase lock loops to determine performance in the presence of noise.

2 MHz Frequency Range
Besides the pseudo-random analog and digital noise, the Model 132 is a source of precision sine, square and triangle waveforms with a frequency range of 0.2 Hz to 2 MHz. This unique instrument gives you the typical function generator versatility, quality and accuracy for your general laboratory applications.



VERSATILITY

Waveforms
Sine ∿, square ⊓, triangle △, digital ⎍⎍ noise, analog ⩘ noise, signal-on-noise N/S and noise-on-signal S/N selectable.

Operational Modes

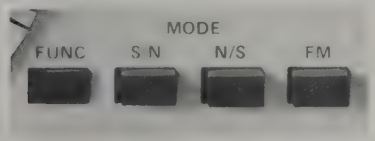
Function: Provides the selected waveform at the main output.

Signal-to-Noise: Adds noise to a selected signal of constant amplitude. The signal-to-noise ratio is variable from 0 to 60 dB.

Noise-to-Signal: Adds a selected signal to a constant amplitude noise. The noise-to-signal ratio is variable from 0 to 60 dB.

Frequency Modulation: Provides random modulation of the frequency of the generator. The S/N-N/S (dB) ratio control also controls the amount of frequency deviation.

NOTE: When noise is added to the signal output, specifications apply up to 200 kHz and the square wave rise time is derated by a factor of 10. In the clock range of 1.6 MHz, the maximum calibrated signal-to-noise ratio is 30 dB.



Mode Controls

Frequency Range
For ∿, ⊓, △, 0.2 Hz to 2 MHz in 6 overlapping ranges with decade dial and frequency vernier.
NOTE: Noise not controlled by dial or range switch.

Main Output
∿, ⊓, △, ⎍⎍ and ⩘ selectable and variable to 20 Vp-p (10 Vp-p into 50Ω). Voltage attenuation 0 to 60 dB in 10 dB steps with overlapping calibrated vernier. Output impedance 50Ω; 600Ω available. Short circuit current is 100 mA.

DC Offset
Waveform offset selectable through 50Ω output. Adjustable between ±5V max (±2.5V into 50Ω load).

Sync Output
Greater than 1 Vp-p square wave into open circuit 600Ω output impedance.

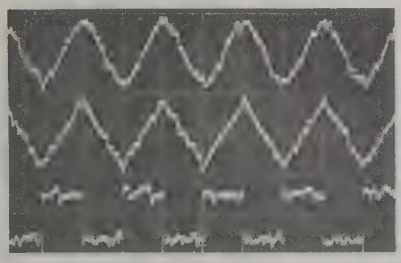
VCG—Voltage Controlled Generator
Frequency change up to 1000:1 with external 0 to ±5V signal. Upper frequency limited to maximum of selected range.
Slew Rate: 0.1V per μs.
Input Impedance: 1 kΩ.

Digital Noise
⎍⎍ is digital sequence of pseudo-random width pulses with a selectable, repeating sequence length of $2^{10}-1$, $2^{15}-1$ or $2^{20}-1$ clock counts; minimum pulse width is one clock count. Noise clock frequency is selectable from 160 Hz to 1.6 MHz in 4 ranges. A sync pulse occurs at the beginning of each sequence.

Pseudo-Random Noise Controls

Analog Noise
⩘ is band-limited white noise with bandwidth adjustable from 10 Hz to 100 kHz in 4 ranges.

Signal and Analog Noise Mix
In N/S mode signal amplitude can be varied from 0 to −60 dB in five 10 dB steps and 10 dB vernier. In S/N mode the noise can be varied as above. Total signal amplitude controlled by output attenuator.



Signal and Analog Noise

FREQUENCY PRECISION

Dial Accuracy
±2% of full scale for 1 Hz to 2 MHz.

Time Symmetry
±1% through ×100K range.

AMPLITUDE PRECISION

Amplitude Change With Frequency
Sine variation less than:
±0.1 dB for 0.2 Hz to 200 kHz.
±0.5 dB for 0.2 Hz to 2 MHz.

Step Attenuator Accuracy
±0.25 dB per 10 dB step.

WAVEFORM CHARACTERISTIC

Sine Distortion
Less than:
0.5% for 0 to 20 kHz.
1.0% for 20 kHz to 200 kHz.
All harmonics 30 dB down on X1M range.

Square Wave Rise and Fall Time
Less than 50 ns terminated into 50Ω.

GENERAL

Stability
Amplitude, frequency and dc offset.
Short Term: ±0.05% for 10 min.
Long Term: ±0.25% for 24 hours.

Environment
Specifications apply at 23° ±5°C. Instrument will operate from 0° to +50°C.

Dimensions
21.6 cm (8½ in.) wide; 13.3 cm (5¼ in.) high; 29.2 cm (11½ in.) deep.

Weight
3.6 kg (8 lb) net; 5.4 kg (12 lb) shipping.

Power
105 to 125V or 200 to 250V; 50 to 400 Hz; less than 55 VA.

NOTE: Specifications apply when frequency dial is between 0.1 and 2.0 and output is 10 Vp-p into 50Ω load.

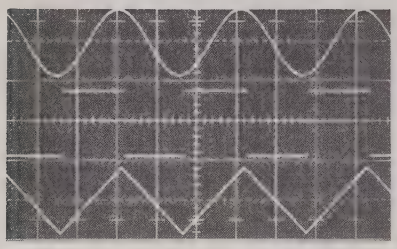
FACTORY/FOB

San Diego, CA

PRICE

Model 132	**$2195**

Synthesizer / Function Generator



- **Combination Function Generator/Synthesizer**
- **4½ Digit or 1000:1 Dial Control**
- **0.005% Frequency Accuracy**
- **−70 dB Spurious Noise**
- **0.1 Hz to 2 MHz Frequency Range**

Combination Function Generator/ Synthesizer
Model 171 combines a function generator and 4½ digit resolution frequency synthesizer in one package.

4½ Digit or 1000:1 Dial Control
Frequency control is by dial or digital switch. You can use digital control in the synthesizer mode with frequency resolution from 0.001 Hz on the lowest decade range to 100 Hz on the highest range. Resolution is a full 4½ digits (1.9999). Dial control, in the generator mode, provides ±3% full scale accuracy with infinite resolution.

0.005% Frequency Accuracy
In the synthesizer mode, the output waveform is phase locked to an internal crystal providing ±0.005% frequency accuracy with frequency stability of 0.0001% per °C.

−70 dB Spurious Noise
In the synthesizer mode, the spurious signals are typically 70 dB below the fundamental for frequencies up to 20 kHz.

0.1 Hz to 2 MHz Frequency Range
Model 171 frequency range is 0.1 Hz to 2 MHz in the function generator mode. In the synthesizer mode, range is from 1 Hz to 2 MHz. You have either mode, function generator or synthesizer, with the flip of a switch.

Two Simultaneous Outputs
Model 171 features two simultaneous outputs with a maximum of 10 volts peak-to-peak into matched termination. The outputs are from 50 and 600Ω sources. The output is continuously variable from 0 to −80 dB with a combination step and vernier attenuator.

VERSATILITY

Waveforms
Sine ∿, triangle ∿, square ⊓⊔ and DC selectable. TTL pulse ⎍ and 1 MHz reference pulse ⎍.

Operational Modes

Dial or Digital Switch Selection

Synthesizer: Operates as a synthesizer with function generator outputs locked to the synthesizer frequency. The frequency is determined by the frequency multiplier switch and the digital switch settings. The digital switch is operable between 0.1000 and 1.9999 on all ranges above the ×1 range.

Function Generator: Operates as a conventional VCG. The frequency is controlled by the dial, multiplier and external VCG voltage on all ranges.

Frequency Range
0.1 Hz to 2 MHz in 7 overlapping decade ranges with dial; 6 overlaping ranges with digital switch.

NOTE: Digital switch valid with all frequency multipliers except ×1 (first range). Frequency ratio of 1000:1 on dial, 20:1 on digital switch.

Main Output
∿, ∿, ⊓⊔ variable to 20 Vp-p (10 Vp-p with matching load at either 50Ω or 600Ω) output. Attenuation from 0 to 80 dB: 60 dB in 20 dB steps with a 20 dB vernier.

DC Offset and DC Output
DC offset of waveform and dc output are selectable and variable through ±10V (±5V into matching load). Waveform plus offset is limited to ±10V peak (open circuit). Step attenuator attenuates dc level.

TTL Pulse Output
TTL pulse has an approximately 50% duty cycle at generator frequency and can drive up to 20 TTL loads.

GCV—Generator Controlled Voltage
0 to +2V (nominal, open circuit) proportional to frequency of main generator. Output impedance 600Ω.

VCG—Voltage Controlled Generator
VCG in function generator mode only. Up to 1000:1 frequency change with external 0 to ±2V signal. Upper frequency is limtied to maximum of selected range.
Input Impedance: 2 kΩ.
Slew Rate: 0.1 V/μs.

External Synthesizer Reference Input
Frequency: 1 MHz
Waveform: Sine or Square.
Level: 1 to 10 Vrms
Impedance: 5 kΩ.

Ext Ref Input

Synthesizer Reference Output Signal
TTL 1 MHz pulse train (in synthesizer mode only).

FREQUENCY PRECISION

Synthesizer Mode
Accuracy: 0.005% of setting.

Range	Digital Resolution
1.000 Hz to 20 Hz	0.001 Hz
10.00 Hz to 200 Hz	0.01 Hz
100.0 Hz to 2 kHz	0.1 Hz
1.000 kHz to 20 kHz	1.0 Hz
10.00 kHz to 200 kHz	10 Hz
100.0 kHz to 2 MHz	100 Hz

Locking Time: Within .01% of final frequency in <300 ms on ×1K, ×10K, ×100K and ×1M range.

Function Generator Mode
Dial Accuracy: ±3% of full scale for 0.1 Hz to 200 kHz. ±5% of full scale to 2 MHz.
Time Symmetry: ±1% on all ranges except ×1M range.

AMPLITUDE PRECISION

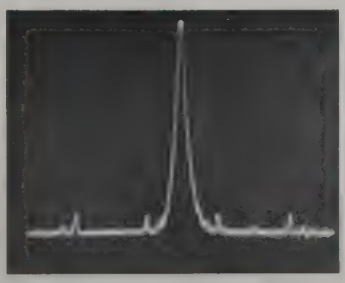
Amplitude Change With Frequency
Sine variation less than:
±0.1 dB for 0.1 Hz to 200 kHz.
±0.5 dB for 200 kHz to 2 MHz.

Step Attenuator Accuracy
±0.3 dB per 20 dB step.

WAVEFORM CHARACTERISTICS

Sine Distortion
Less than:
0.5% for 0.1 Hz to 20 kHz.
1.0% for 20 kHz to 200 kHz.
All harmonics 30 dB below fundamental on ×1 MHz range.

Spurious Signals
Typically 70 dB below fundamental to 20 kHz and 40 dB below fundamental to 2 MHz (in synthesizer mode only).



Typical Spectral Purity in the Synthesizer Mode

Integrated Signal to Phase Noise
Typically 30 dB to 200 kHz measured over ±15 kHz bandwidth excluding carrier ±10 Hz (in synthesizer mode only).

Triangle Linearity
Greater than 99% to 200 kHz.

Square Wave Rise and Fall Time
Less than 75 ns.

TTL Pulse Rise and Fall Time
Less than 25 ns (15 ns typical).

GENERAL

Synthesizer Stability
Frequency: 1 ppm/°C.
Internal Crystal Frequency: 4 MHz.
Aging Rate: 20 ppm/year.

Function Generator Stability
Amplitude, dc offset and frequency.
Short Term: ±0.05% for 10 minutes.
Long Term: ±0.25% for 24 hours.

Environment
Specifications apply at 23° ±5°C. Instrument will operate from 0° to +50°C.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 27.3 cm (10¾ in.) deep.

Weight
3.9 kg (8.5 lb) net; 5.5 kg (12 lb) shipping.

Power
90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 20 VA.

NOTE: All specifications apply when frequency dial is between 0.1 and 2.0 or digital switch is between 0.1000 and 1.9999, amplitude is at 10 Vp-p and output is from the 50Ω BNC into a 50Ω load

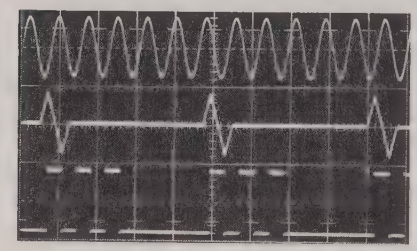
FACTORY/FOB

San Diego, CA

PRICE

Model 171	**$1595**

4 MHz Function Generators



- **0.004 Hz to 4 MHz Frequency Range**
- **Trigger and Gate Modes**
- **20 Volt Peak-to-Peak Output**
- **DC Offset with Calibrated Zero**
- **1000:1 Lin/10,000:1 Log Sweep (188)**

Wide Frequency Range
Models 182A and 188 cover a wide 4 mHz to 4 MHz frequency span in seven overlapping ranges. Each multiplier setting gives a full 1000:1 frequency band.

In addition, the Model 188 also has a 10,000:1 logarithmic frequency range.

Trigger and Gate
In triggered mode, your manual or external TTL signal initiates a single waveform cycle. Gated mode is similar except there is a burst of waveform cycles for the duration of the signal.

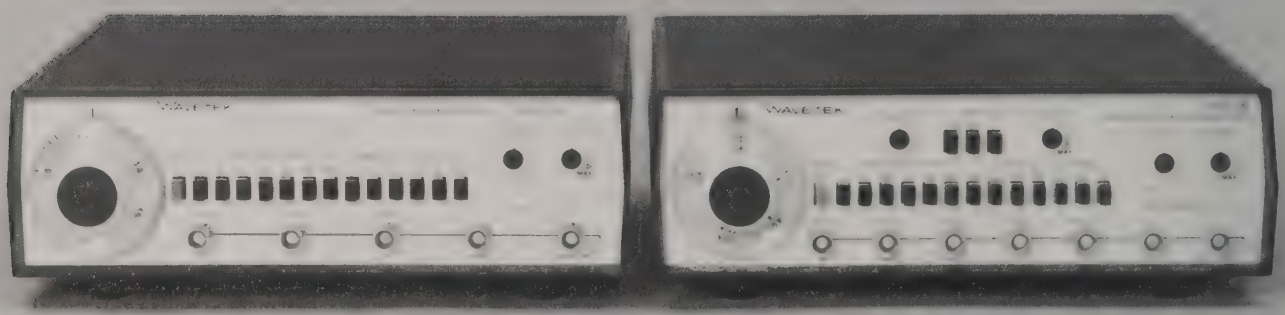
Sweep (Model 188)
In addition to trigger and gates modes, Model 188 has a ramp generator to sweep its main generator. With sweep, the output frequency repeatedly sweeps up at the desired rate in a selected linear (3 decades) or logarithmic (4 decades) mode.

Output
High level output is a full 20 volts peak-to-peak from a 50Ω termination) with maximum peak current of 100 milliamperes. This high power output allows you to drive low impedance and capacitive loads without saturating or degenerating the waveform output. In addition to high level output, both instruments have a low level (down 20 dB from the high level) output. Both outputs can be varied a full 30 dB.

Voltage Controlled Generator
You can externally modulate or sweep the generator frequency in each of its 1000:1 ranges with dc or ac signals. (Model 188 range is 10,000:1 in logarithmic mode.) For example, you can sweep the entire 40 Hz to 40 kHz audio band without switching ranges.

DC Offset With Calibrated Zero
Convenient front panel dc offset control lets you easily raise or lower the output waveform with respect to normal signal ground. Turning the DC offset switch off balances the waveform at a calibrated zero offset.

TTL Pulse Output
For your convenience, these models have an auxiliary TTL pulse output at generator frequency for synchronization or for digital applications.



MODELS 182A & 188 FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine ∿, triangle △, square ⊓, TTL pulse ⎍ and dc.

Operational Modes
Continuous: Generator runs continuously at selected frequency.
Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one complete waveform cycle starting at 0° and at selected frequency.
Gated: As triggered mode, except output continues for duration of gate signal. Last waveform started is completed.
Sweep: (188 only.) Recurring low-to-high frequency oscillation. Range, rate and mode (linear or logarithmic) selectable.
Sweep Stop: (188 only.) Frequency sweeps to high sweep limit. Used to set high frequency limit.

Frequency Range
0.004 Hz to 4 MHz in 7 overlapping decade ranges.

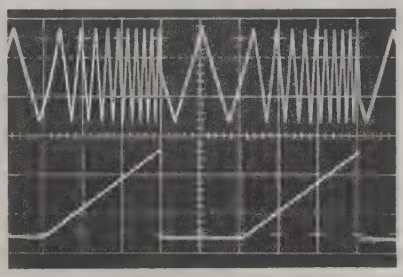
Function Output (50Ω OUT)
∿, ⊓, △ selectable and variable to 20 Vp-p (10 Vp-p into 50Ω) HI output, and to 2 Vp-p (1 Vp-p into 50Ω) LO output. Both outputs varied with a 30 dB vernier. Peak output current is 100 mA maximum (HI output). Source impedance is 50Ω.

DC Offset and DC Output
Waveform offset and dc output selectable and variable through HI and LO BNC outputs. DC output selectable by not selecting a waveform function. HI output is ±10V max (±5V into 50Ω) as offset or Vdc output. Signal- peak plus offset limited to ±10V (±5V into 50Ω). LO output is ±1V max (±0.5V into 50Ω) as is signal- peak plus offset limit. DC offset plus waveform attenuated proportionately at LO (−20 dB) output.

TTL Pulse Output
TTL pulse (50% duty cycle) at generator frequency. Drives up to 20 TTL loads.

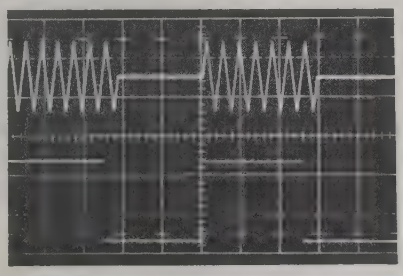
GCV—Generator Controlled Voltage
(188 only.) 0 to 4V open circuit output from 600Ω source impedance. Proportional to frequency of main generator. For use as a horizontal drive signal.

VCG—Voltage Controlled Generator
With external 0 to ±4V signal:
Linear Mode: Up to 1000:1 frequency change.
Log Mode: (188 only.) Up to 10,000:1 change. Upper and lower frequencies limited to maximum and minimum of selected range.
Slew Rate: 2% of range per μs (linear); 0 to 100% of range in 20 ms (logarithmic).
Linearity: ±0.5% thru ×100K range; ±2% on ×1M range.
Input Impedance: 2 kΩ.



VCG Input (lower) and Generator Output

Trigger and Gate
Input: TTL compatible levels.
Pulse Width: 50 ns minimum.
Repetition Rate: 4 MHz maximum.



Trigger Input (lower) and Generator Output

Sweep (188)
Main generator is frequency modulated by internal sweep generator. Main generator frequency repeatedly rises from frequency set by dial and range button to frequency set by sweep stop knob.
Sweep Mode: Linear (3 decades max) or logarithmic (4 decades max).
Sweep Rate: 30 ms to 1 min (nominal) continuously adjustable.
Sweep Width: Up to 1:1000 (linear) or 1:10,000 (logarithmic) continuously adjustable.

Sweep Output (188)
Ramp waveform output with 4V peak into open circuit. For use as a horizontal drive signal.
Source Impedance: 600Ω.

FREQUENCY PRECISION

Dial Accuracy
±5% of full scale.

Time Symmetry
Square wave variation from 0.2 to 4.0 on dial:
To 100 kHz: <±1%
To 4 MHz: <5%.

AMPLITUDE PRECISION

Sine variation (referenced to 1 kHz) with frequency—
On All Ranges Through ×100K: <±0.2 dB.
To 4 MHz: <±1.0 dB.

WAVEFORM CHARACTERISTICS

Sine Distortion
On Ranges—
×1K and ×10K: <0.5%.
×1, ×10, ×100 and ×100K: <1%.
X1M: All harmonics 25 dB below fundamental.

Triangle Linearity
Greater than 99% to 200 kHz.

Square Wave Rise and Fall Time
At HI output, less than 50 ns for 10 Vp-p output into 50Ω termination.

GENERAL

Environment
Specifications apply at 23° ±5°C. Instrument will operate from 0° to 50°C ambient temperatures.

Dimensions
28.6 cm (11¼ in.) wide; 8.9 cm (3½ in.) high; 26.7 cm (10½ in.) deep.

Weight
182A: 2.5 kg (5.4 lb) net; 3.6 kg (8 lb) shipping.
188: 2.5 kg (5.4 lb) net; 3.6 kg (8 lb) shipping.

Power
90 to 128V or 198 to 256V (selectable); 48 to 66 Hz; less than 15 VA.

NOTE: All specifications apply for dial between 0.2 to 4.0; amplitude at 10 Vp-p from HI output into 50Ω termination.

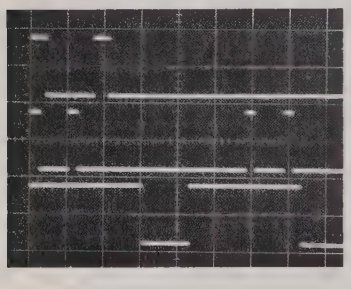
FACTORY/FOB

San Diego, CA

PRICE

Model 182A	**$495**
Model 188	**$695**

4 MHz Pulse/Function Generator



- 0.004 Hz to 4 MHz Frequency Range
- Variable Width and Delay Pulses
- Trigger and Gate Modes
- 20 Volt Peak-to-Peak Output
- Fixed Base Line and DC Offset

Pulses Plus Waveforms
Two indispensable instruments in one, Model 187 is both a pulse and function generator that produces variable pulses as well as function generator waveforms.

Frequency Range
Seven overlapping 1000:1 frequency ranges cover a wide 4 mHz to 4 MHz. Frequency may be set with the calibrated dial or externally modulated or swept across the entire range.

Pulse Control
Variable width and delay pulse output may be single or double pulses per period, inverted or normal.

Trigger and Gate
Model 187 is also a complete function generator with precision waveforms in continuous, triggered and gated modes. In continuous mode, the waveform is generated repetitively at the selected frequency. In triggered mode, the generator remains quiescent at a dc baseline until your external signal or manual trigger initiates a single waveform cycle. The third mode, gated, is similar to triggered except the generator produces a burst of waveform cycles for the duration of the manual or external signal.

Output
High level output is a full 20 volts peak-to-peak from a 50Ω source (10 Vp-p into 50Ω termination) with maximum peak current of 100 milliamperes. This high power output allows you to drive low impedance and capacitive loads without saturating or degenerating the waveform output. In addition to high level output, the 187 has a low level (down 20 dB from the high level) output. Both outputs can be varied a full 30 dB.

DC Offset with Calibrated Zero
All waveforms and pulses can be offset a full ± 10 volts. Fixed baseline pulses allow adjustment of pulse amplitude without the need to adjust DC offset level.

MODEL 187 FUNCTION GENERATORS

VERSATILITY

Instrument operates as either a function generator or pulse generator.

Functions
Sine ∿ ; triangle ∿ ; square ⊓ ; fixed baseline normal pulses ⎍ , ⎍ , ⎍ and inverted pulses ⎎ , ⎎ , ⎎ ; and dc.

Operational Modes
Continuous: Generator runs continuously at selected frequency.
Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one complete waveform cycle at selected frequency.
Gated: As triggered mode, except output continues for duration of gate signal. Last waveform started is completed.

Frequency Range
0.004 Hz to 4 MHz in 7 overlapping decade ranges.

Main Outputs (50Ω OUT)
∿ , ∿ , ⊓ , ⎍ selectable and variable to 20 Vp-p (10 Vp-p into 50Ω) HI output, and to 2 Vp-p (1 Vp-p into 50Ω) LO output. ⎍ , ⎍ , ⎎ , ⎎ selectable and variable from fixed baseline to 10 Vp-p (5 Vp-p into 50Ω) HI output, and to 1 Vp-p (0.5 Vp-p into 50Ω) LO output. Both outputs varied with a 30 dB vernier. Peak output current is 100 mA maximum (HI output). Source impedance is 50Ω.

DC Offset and DC Output
Function baseline offset and dc output selectable and variable through HI and LO BNC outputs. DC only output selected by not selecting a function. HI output is ± 10V max (± 5V into 50Ω) as offset or Vdc output. Signal-peak plus offset limited to ± 10V (± 5V into 50Ω). LO output is ± 1V max (± 0.5V into 50Ω) as is signal-peak plus offset limit. DC offset plus waveform attenuated proportionately at LO (– 20 dB) output.

Pulse Modes
Square ⊓ : 50% duty cycle; amplitude balanced with respect to dc offset level.
Pulse: Adjustable width pulse in phase with sync signal.
Delayed Pulse: Pulse delayed with respect to sync out. Pulse delay and pulse width adjustable.
Double Pulse: Time between pulses and time of pulse width adjustable. Second pulse not generated if delay <width.

Pulse Period Range
250 ns to 250s in 7 overlapping decade ranges.

Pulse Width
100 ns to 100 ms in 3 ranges with vernier control. Has no effect in ⊓ mode.

Pulse Delay
100 ns to 100 ms in 3 overlapping ranges with vernier control.

Sync Output
TTL pulse (50% duty cycle) at generator frequency. Drives up to 20 TTL loads.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ± 4V signal. Upper and lower frequencies limited to maximum and minimum of selected range.
Slew Rate: 2% of range per μs.
Linearity: ± 0.5% through × 100K range; ± 2% on × 1M range.
Input Impedance: 2 kΩ.

Trigger and Gate
Input: TTL compatible levels.
Pulse Width: 50 ns minimum.
Repetition Rate: 4 MHz maximum.

FREQUENCY PRECISION

Dial Accuracy
± 5% of full scale.

Time Symmetry
Pulse variation from 0.2 to 4.0 on dial less than:
± 1% to 100 kHz;
± 5% to 4 MHz.

AMPLITUDE PRECISION

Sine variation with frequency less than:
± 0.2 dB on all ranges through × 100K, referenced to 1 kHz;
± 1.0 dB to 2 MHz.
± 5% to 4 MHz.

FUNCTION CHARACTERISTICS

Sine Distortion
Less than:
0.5% on × 1K and × 10K ranges;
1% on × 1, × 10, × 100 and × 100K ranges.
All harmonics 25 dB below fundamental on × 1M range.

Triangle Linearity
Greater than 99% to 200 kHz.

Pulse Rise and Fall Time
At HI output, less than 50 ns for 10 Vp-p output into 50Ω termination.

GENERAL

Environmental
Specifications apply at 23°C ± 5°C. Instrument will operate from 0°C to 50°C ambient temperatures.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 26.7 cm (10½ in.) deep.

Weight
2.7 kg (6 lb) net; 4.5 kg (10 lb) shipping.

Power
90 to 128V or 198 to 256V; 48 to 66 Hz; less than 15 VA.

NOTE: All specifications apply for dial between 0.2 and 4.0; amplitude at 10 Vp-p from HI output into 50Ω termination.

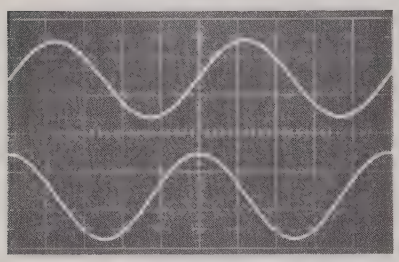
FACTORY/FOB

San Diego, CA

PRICE

Model 187	**$895**

5 MHz Phase Lock Generator



- 0.0001 Hz to 5 MHz Frequency Range
- Phase Lock to External Frequency
- 30V Peak-to-Peak Output
- AM/FM with Internal or External Modulation

Phase Lock to External Frequency
Lock the 186 to your reference by tuning the main frequency dial to the reference frequency. When the lock indicator lights, you can control the phase relationship of the reference signal and generator signal over 360 degrees with the phase control dial.

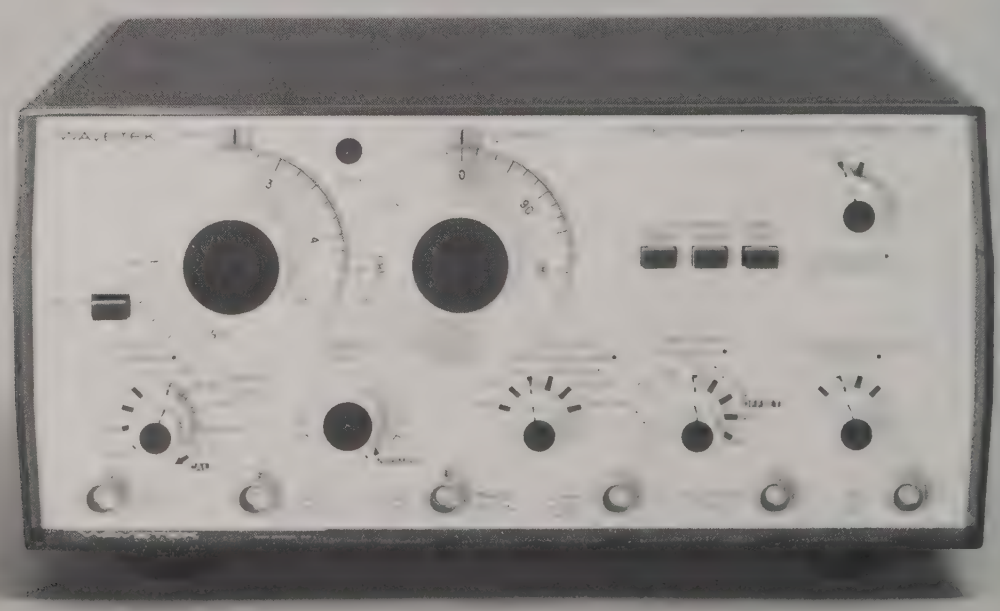
30V Peak-To-Peak Output
The output amplifier delivers 30V peak-to-peak amplitude from a 50Ω source; 15V peak-to-peak into a 50Ω load. The front panel has a 0 to 80 dB attenuator for generating signals as small as 1.5 mV when you need them.

AM/FM With Internal or External Modulation
Modulate the output signal in amplitude or frequency by an internal 1 kHz sine wave or by an external waveform with frequencies up to 5 MHz.

Variable Pulse Width and Ramp Control
Use the symmetry control to dial the exact pulse width or ramp slope you need for your individual tests. Symmetry, or duty cycle, can be varied from 5% of cycle time on the first half of the waveform, and 95% on the second half, to 95% on the first half, and 5% on the second.

Triggered and Gates Modes
Single cycle and multiple cycle bursts are required stimuli for many tests. You can get them by using the manual front panel control or an external command signal. Any of the output waveforms can be triggered or gated.

0.0001 Hz to 5 MHz Frequency Range
Frequency range is from 0.0001 Hz to 5 MHz in 10 ranges with 25 calibration points on the main frequency dial. You can make an additional frequency adjustment with the frequency vernier which has a range of 1% of the dial range.



VERSATILITY

Waveforms
Sine ∿, triangle △, square ⊓, positive pulse ⎍, negative pulse ⎎, haversine ⌒, ramp ◿, waveform inversions, symmetry variations, AM ◇◇, FM ⩛, TTL pulse ⎍ and dc.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.
Triggered: Generator quiescent until triggered by an external signal, then generates one cycle at selected frequency.
Gated: As triggered mode, except generator oscillates for the duration of the external signal. Last cycle started will be completed.
Phase Lock: Generator will phase lock to an external signal and generator waveforms will lead or lag input signal by amount selected.
1 kHz AM: Selected generator output amplitude modulated at 1 kHz sine wave rate; the amount, zero thru suppressed carrier, is adjustable.
1 kHz FM: Selected generator output frequency modulated at 1 kHz sine wave rate; the amount of deviation from center frequency is adjustable.

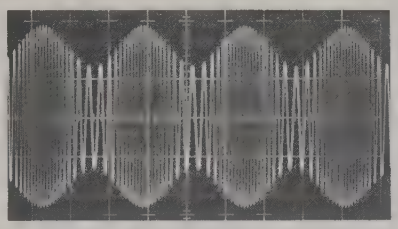
Frequency Range
0.0001 Hz to 5 MHz in 10 overlapping decade ranges with frequency dial and vernier.

Main Output
∿, △, ⊓, ◇◇, ⩛ selectable and variable to 30 Vp-p (15 Vp-p into 50Ω). ⎍, ⎎, selectable and variable to ± 15V max (7.5V into 50Ω). ⌒ based at 0 volts and amplitude control varies peak to + 15V max. Waveforms may be inverted. Voltage attenuation 0 to 80 dB: to 60 dB in 20 dB steps plus 20 dB vernier. Output impedance 50Ω.

DC Offset and DC Output
Waveform offset and dc output selectable through 50Ω output. Adjustable between ± 15V max (± 7.5V into 50Ω load) as offset or Vdc output. Signal peak plus dc offset limited to ± 15V (± 7.5V into 50Ω). DC offset and output waveform are attenuated proportionately by the attenuator.

TTL Pulse Output
TTL pulse at generator frequency; rise and fall times typically 15 ns. Duty cycle variable by symmetry control. Drives up to 20 TTL loads.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ± 5V signal. Upper frequency is limited to maximum of selected range.
Slew Rate: 2% of range per μs.
Linearity: 0.5% for 0.0001 Hz to 50 kHz.



Voltage Controlled Amplitude and Frequency

VCA—Voltage Controlled Amplitude
Zero to 30V amplitude change with external 0 to ± 5V signal. AC output allows zero to suppressed carrier modulation.
Input Impedance: 3 kΩ.
Input Bandwidth: 5 MHz.

Phase Lock
Input Frequency Range: 10 Hz to 5 MHz.
Input Impedance: 1 MΩ.
Input Voltage Range: 1 to 10 Vp-p.
Dynamic Range: 10:1 (0.5 to 5 on dial in any range except × 10).
Phase Accuracy: ± 7.5° of setting to 50 kHz. Phase dial calibrated for ∿ and ∿ ; 90° shift for ⊓ and ⎍ .
Capture Range: Approx ± 2% of input frequency.
Hold Range: Approx ± 5% of input frequency.

Phase Control

Symmetry Control
Waveform symmetry is continuously adjustable from 1:19 to 19:1 for ramps and pulses.

NOTE: When SYMMETRY control is used, indicated frequency is divided by approximatey 10.

Trigger and Gate
Input Range: 1 to 10 Vp-p (± 25V max).
Impedance: 1 MΩ.
Pulse Width: 50 ns min.
Repetition Rate: 5 MHz max.

1 kHz ∿ Output
Level: 10 Vp-p.
Impedance: 1 kΩ.

FREQUENCY PRECISION

Dial Accuracy
± 2% of full scale for 0.005 Hz to 5 MHz.
± 4% of reading and ± 2% of full scale for 0.0005 to 0.005 Hz.

Time Symmetry
± 1% for 0.005 Hz to 500 kHz.

AMPLITUDE PRECISION

Amplitude Change With Frequency
Sine variation less than:
± 0.1 dB of 0 to 100 kHz.
± 0.2 dB for 100 kHz to 1 MHz.
± 1.5 dB for 1 to 5 MHz.

Amplitude Symmetry
1% of amplitude range to 1 MHz.

Step Attenuator Accuracy
± 0.3 dB per 20 dB step.

WAVEFORM CHARACTERISTICS

Sine Distortion (Continuous Mode)
Less than:
0.5% for 10 Hz to 50 kHz.
1.0% for 0.005 Hz to 500 kHz.
All harmonics at least 25 dB down for × 1 MHz range.

Triangle Linearity
Greater than 99% for 0.0005 Hz to 100 kHz.

Square Wave Rise and Fall Time
Less than 50 ns terminated into 50Ω load.

GENERAL

Stability
Amplitude, dc offset and frequency.
Short Term: ± 0.05% for 10 min.
Long Term: ± 0.25% for 24 hours.

Environmental
Specifications apply at 23°C ± 5°C. Instrument will operate from 0°C to + 50°C.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 27.3 cm (10¾ in.) deep.

Weight
3.9 kg (8.5 lb) net; 5.5 kg (12 lb) shipping.

Power
90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 35 VA.

NOTE: Specifications apply from 10 to 100% of a selected frequency range, with SYMMETRY control to NORMAL and WAVEFORM pushbutton to NORM. Symmetry and vernier affect frequency claibration. Maximum possible asymmetry is a function of frequency setting

FACTORY/FOB

San Diego, CA

PRICE

Model 186	**$1395**

11 MHz Stabilized Function Generator

- 100 μHz to 11 MHz Range
- Crystal Stabilized to 0.09%
- External Reference and Waveform Hold
- LCD Display With Annunciator
- Triggered, Gated and Haver Waveforms

Crystal Stabilized Operation
Model 21 features frequency stabilized operation. Stabilization extends tight short-term specs (0.09% of range) to indefinite periods throughout the entire 100 μHz to 11 MHz range.

Low-Frequency Waveform Synthesis
Waveforms below 1.1 kHz are synthesized digitally to provide additional features of up and down ramps, haverwaves, instantaneous hold/continue, and operation down to ultra-low frequencies with external reference.

Triggered, Gated, and Haver Waveforms
These waveforms give the instrument additional flexibility. In triggered mode, output is a DC baseline until a manual or external signal initiates a single cycle of the selected waveform. By selecting "Haver" a haverwave is produced. This waveform is a useful simulation of a shock pulse used in mechanical testing. Gated mode is similar to triggered except the generator produces a burst of waveform cycles for the duration of the external triggering signal.

LCD Display
Frequency is monitored by a 3½ digit LCD display. Display annunciators point to selected parameters to show the instrument setup at a glance.

20 Vp-p Amplitude
Output is 20V peak-to-peak (10 Vp-p into 50Ω) at the primary output. A second output is attenuated 20 dB with respect to the first. Both outputs can be varied 20 dB, which gives a full 40 dB output range.

MODEL 21 FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine ∿, triangle △, square ⊓ and dc ⎓; additionally, below 1100 Hz ramp up ◿, ramp down ◺ and haverwaves ⩘, ⩗.

Operational Modes
Continuous: Generator runs continuously at selected frequency.
Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one complete waveform cycle at selected frequency.
Gated: Generator output is continuous for duration of external or manual trigger.
Haver: Same as triggered or gated modes except waveform starts at 270° phase.

Frequency Range
100 μHz to 11 MHz in 9 overlapping decade ranges. Each range capable of 1100:1 frequency change.

Frequency Control
Value or VCG.
Value: Range is selected with front panel key; frequency within range is set with coarse and fine tune controls.
VCG: Up to 1100:1 frequency change with external 0 to ±5V signal applied to VCG input connector. Upper and lower frequencies limited to maximum and minimum of selected range. VCG input is disconnected when stabilizer is engaged.
Input Impedance: 5kΩ.
Slew Rate: 0.1 V/μs (max.).

Amplitude Range
20 dB range up to 20 Vp-p (10 Vp-p into 50Ω) at Func Out (50Ω). Additional output attenuated 20 dB with respect to main output for total amplitude range of 40 dB.

DC Offset and DC Output
Variable up to ±10V maximum (±5V into 50Ω). Calibrated zero offset position. Signal peak plus offset limited to ±10V (±5V into 50Ω).

Outputs
Func Out (50Ω): Main waveform output.
Func Out (−20 dB): Output attenuated 20 dB with respect to main output.
Sync Out: TTL pulse (50% duty cycle) at generator frequency. Will drive 10 LS TTL loads.

Inputs
VCG In: BNC input for voltage control of generator frequency in nonstabilized modes.
Trig In: BNC input accepts TTL compatible signal to trigger or gate the generator. Generator triggers on positive edge of input or gates on for duration of high level input. External signal pulse width is 50 ns minimum with a maximum repetition rate of 5 MHz.
Ext Ref: BNC input for external reference operation or electrical waveform hold.

Stabilizer
When stabilizer is selected, generator frequency is stabilized at displayed frequency to a crystal-controlled reference. Stabilizer improves long term frequency stability for all durations to be equal to the 10 minute short term value.

Display
1100 count LCD frequency display with frequency ranging units (mHz, Hz, kHz and MHz) and decimal point. Annunicators indicate selection of modes and functions.

External Reference
External Reference switch provides selection of internal or external control of waveform output frequency and also provides a means of holding or releasing the waveform manually, electrically or through external contact closure. External Reference connector accepts either TTL compatible signal (1.1 MHz maximum repetition rate, 200 ns minimum pulse width) or contact closure. Operation with external reference provides output frequency 1/1000 of reference frequency. Contact closure to ground stops waveform; opening contact causes waveform to start again exactly where it stopped.

FREQUENCY PRECISION

Frequency Display Accuracy
±1 count of 1100 counts, which is 0.09% of range. Stabilizer maintains same reading indefinitely.

Time Symmetry
Square waveform variation from 100 to 1100 counts on display less than: ±0.1% to 1100.00 Hz (across bottom five specified ranges), ±1% to 110.00 kHz,
±5% to 11.00 MHz.

AMPLITUDE PRECISION

Sine Variation with Frequency
Referenced to 1 kHz.
All ranges to 110.0 kHz: < ±0.2 dB
To 11.00 MHz: < ±1.5 dB.

WAVEFORM CHARACTERISTICS

Sine Distortion
1.00 to 11.00 kHz range: <0.5% THD.
10.0 to 110.0 kHz range: <1% THD.
0.100 to 1.1 MHz range: < −40 dBc.
1.0 to 11.0 MHz range: < −28 dBc.

Triangle Linearity
To 110 kHz: >99%.

Square Wave Rise and Fall Times
<22 ns at Function Out with 10 Vp-p into 50Ω.

Square Wave Total Aberrations
Each peak <5% of p-p amplitude.

Stability
Amplitude, frequency (nonstabilized) and dc offset after 30 minute warm-up:
±0.10% of range for 10 minutes.
±0.50% of range for 24 hours.
Frequency (stabilized):
±0.09% of range for ⩾10 minutes, 0 to 50°C.

GENERAL

Output Protection
Function outputs are protected against a short circuit to any voltage between ±10 Vdc and have internal fused protection (both output and common conductors) against accidental application of up to 250 Vac or 350 Vdc.

Environment
Temperature Range: 23° ±5°C for specified operation, operates 0° to +50°C, −20° to +75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft. for operation. Sea level to 40,000 ft. for storage.
Relative Humidity: 95% at 25°C at sea level (noncondensing).

Dimensions
211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep.

Weight
3.4 kg (7.5 lb) net; 4.5 kg (10 lb) shipping.

Power
90 to 128, 180 to 256V, 48 to 66 Hz, less than 35 VA.

NOTE: All specifications apply for display between 100 and 1100 frequency counts, amplitude at 10 Vp-p into 50Ω.

FACTORY/FOB

San Diego, CA

PRICE

Model 21	**$1095**

11 MHz Stabilized Sweep Generator

- **100 μHz to 11 MHz Range**
- **Crystal Stabilized to 0.09%**
- **Linear and Logarithmic Sweep**
- **LCD Display**

Crystal Stabilized Operation
Model 22 features frequency stabilized operation. Stabilization extends tight short-term specs (0.09% of range) to indefinite periods throughout the entire 100 μHz to 11 MHz range.

LCD Display
Frequency is monitored by a 3½ digit LCD display. Display annunicators point to selected parameters to show the instrument setup at a glance.

Low-Frequency Waveform Synthesis
Waveforms below 1.1 kHz are synthesized digitally to provide additional features of up and down ramps.

Linear and Logarithmic Sweep
Model 22 offers linear and logarithmic sweep with selectable sweep times of 0.01 to 10 seconds, and adjustable sweep width up to 1100:1.

20 Vp-p Amplitude
Output is 20V peak-to-peak (10 Vp-p into 50Ω) at the primary output. A second output is attenuated 20 dB with the respect to the first. Both outputs can be varied 20 dB, which gives a full 40 dB output range.

VERSATILITY

Waveforms
Sine ∿, triangle △, square ⊓ and dc; additionally, below 1100 Hz, ramp up ◿ and ramp down ◺.

Operational Modes
Continuous: Generator runs continuously at selected frequency.
Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one complete waveform cycle at selected frequency.
Gated: Generator output is continuous for duration of external or manual trigger.
Set: Generator runs continuously at sweep stop frequency set by Sweep Set control. Sweep stop frequency is displayed.
Sweep: Generator frequency is swept from lower frequency limit set by Frequency control to upper frequency limit set by Sweep Set control in a continuously occurring low to high sweep. Sweep time and choice of linear or logarithmic sweep are selectable.
Triggered Sweep: Generator is quiescent until triggered, then produces a single low to high sweep at selected rate and width.

Frequency Range
100 μHz to 11 MHz in 9 overlapping decade ranges. Each range capable of 1100:1 frequency change.

Frequency Control
Value: Range is selected with front panel key; frequency within range is set with coarse and fine tune controls.
VCG: Up to 1100:1 frequency change with external 0 to ±5V signal applied to VCG input connector. Upper and lower frequencies limited to maximum and minimum of selected range. VCG input is disconnected when stabilizer is engaged.
Input Impedance: 5kΩ.
Slew Rate: 0.1 V/μs (max.).

Amplitude Range
20 dB range up to 20 Vp-p (10 Vp-p into 50Ω) at Func Out (50Ω). Additional output attenuated 20 dB with respect to Func Out (50Ω) for total amplitude range of 40 dB.

DC Offset and DC Output
Variable up to ±10V maximum (±5V into 50Ω). Calibrated zero offset position. Signal peak plus offset limited to ±10V (±5V into 50Ω).

Outputs
Func Out (50Ω): Main waveform output.
Func Out (−20 dB): Output attenuated 20 dB with respect to main output.
Sync Out: TTL pulse (50% duty cycle) at generator frequency. Will drive 10 LS TTL loads.
Sweep Out: Voltage proportional to instantaneous generator frequency.

Inputs
VCG In: BNC input for voltage control of generator in nonstabilized modes.
Trig In: BNC input acccepts TTL compatible signal to trigger or gate the generator. Generator triggers on positive edge of input or gates on for duration of high level input. External signal pulse width is 50 ns minimum with a maximum repetition rate of 5 MHz.

Stabilizer
When stabilizer is selected, generator frequency is stabilized at displayed frequency to a crystal-controlled reference. Stabilizer improves long term frequency stability for all durations to be equal to the 10 minute short term value.

Display
1100 count LCD frequency display with frequency ranging units (mHz, Hz, kHz and MHz) and decimal point. Annunciators indicate selection of modes and functions.

Sweep Generator
Sweep Mode: Linear or logarithmic, up to 3 decades.
Sweep Time: Selectable 0.01, 0.1, 1.0 and 10 seconds.
Sweep Width: Up to 1100:1 linear or logarithmic.
Sweep Output: Voltage proportional to instantaneous generator frequency. Source Impedance: 600Ω for driving horizontal axis of oscilloscope or recording equipment. Voltage of 0 to +5V (open circuit) for frequency change from bottom to top of selected range.

FREQUENCY PRECISION

Frequency Display Accuracy
±1 count of 1100 counts, which is 0.09% of range. Stabilizer maintains same reading indefinitely.

Time Symmetry
Square Waveform Variation From 100 to 1100 Counts On Display:
To 1100.00 Hz (Bottom 5) <±0.1%.
To 110.00 kHz: <±1%.
To 11.00 MHz: <±5%.

AMPLITUDE PRECISION

Sine Variation with Frequency
Referenced to 1 kHz.
To 110.0 kHz Range: <±0.2 dB.
To 11.00 MHz: <±1.5 dB.

WAVEFORM CHARACTERISTICS

Sine Distortion
1.00 to 11.00 kHz Range: <0.5% THD.
10.0 to 110.0 kHz Range: <1% THD.
0.100 to 1.1 MHz Range: <−40 dBc.
1.0 to 11.0 MHz Range: <−28 dBc.

Triangle Linearity
To 110 kHz: >99%.

Square Wave Rise and Fall Times
<22 ns at Function Out with 10 Vp-p into 50Ω.

Square Wave Total Aberrations
Each peak <5% of peak-to-peak amplitude.

Stability
Amplitude, Frequency (Nonstabilized) and DC Offset After 30 Minutes Warm-up:
±0.10% of range for 10 minutes.
±0.50% of range for 24 hours.
Frequency (Stabilized):
±0.9% of range for ⩾10 minutes, 0 to 50°C.

GENERAL

Output Protection
Function outputs are protected against a short circuit to any voltage between ±10 Vdc and have internal fused protection (both output and common conductors) against accidental application of up to 250 Vac or 350 Vdc.

Environment
Temperature Range: 23° ±5°C for specified operation, operates 0° to +50°C, −20° to +75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 95% at 25°C at sea level (noncondensing).

Dimensions
211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep.

Weight
3.4 kg (7.5 lb) net; 4.5 kg (10 lb) shipping.

Power
90 to 128, 180 to 256V, 48 to 66 Hz, <35 VA.

NOTE: All specifications apply for display between 100 and 1100 frequency counts; amplitude at 10 Vp-p into 50Ω.

FACTORY/FOB

San Diego, CA

PRICE

Model 22	**$1295**

12 MHz Synthesized Function Generator

- **10 mHz to 32 MHz Range**
- **4¼ Digit Synthesized Frequency ±0.005% Accuracy**
- **AM, FM, Trigger and Gate**
- **Optionally Programmable via GPIB or RS232**

Wide Frequency Range
Model 23 Function Generator operates from 0.01 Hz to 12 MHz in synthesized, continuous, triggered and gated modes with output levels of 10 mV to 20 Volts peak-to-peak. Frequencies as low as 100 μHz are obtainable in the VCG mode. The synthesizer circuit extends frequency range at the ECL and TTL outputs to 32 MHz. In addition, the synthesized mode has 4 digits of frequency resolution with 0.005% (50 ppm) accuracy.

FM, AM and SCM
Inputs are provided for external frequency and amplitude modulation. Suppressed carrier modulation (SCM) is also obtainable by programming zero amplitude. Carrier suppression is initially at least 40 dB, and may be improved to typically 70 dB (to 1 MHz) by using the NULL control.

Low-Frequency Waveform Synthesis
Waveforms below 1 kHz are synthesized digitally to extend the frequency range down to 0.01 Hz while maintaining high speed phase locking in the frequency synthesized mode. The waveform synthesizer also provides the additional features of up and down ramps and triggered and gated haverwaves.

Friendly Controls
Parameters are selected by front panel keys, and the numeric values are incremented or decremented with the rotary encoder knob. All parameters are displayed on a 16-character by 2 line LCD display. Microprocessor control makes possible frequency and amplitude units conversion, internal calibration and test procedures, and optional remote programming.

Non-Volatile Memory
Instrument set up parameters are stored in memory for return to exact set-up after power down. Memory is maintained with a long-life lithium battery.

MODEL 23 FUNCTION GENERATORS

VERSATILITY

Waveforms
∧, ∿, ⊓ and dc; additionally, below 1000 Hz, ⟋, and ⟍ and, in triggered or gated modes, haverwaves.

Operational Modes
Continuous, triggered, gated, continuous synthesized and clock.

Frequency Range
0.01 Hz to 12 MHz at Function Output. 0.01 Hz to 32 MHz at TTL and ECL outputs. Down to 100 μHz with VCG.

Frequency Control
Programmed value or VCG.
Value: Frequency value is manually or bus programmable with automatic range selection.
VCG (Voltage Controlled Generator): AC or dc input controls frequency. Input disabled in synthesized mode. 0 to ±12V into 10 kΩ for up to 1200:1 frequency change in each of 9 frequency ranges (ranges must be programmed). Slew rate is limited to 0.1 V/μs.

Frequency Zero
In non-synthesized modes, front panel key or bus command sets frequency to bottom of current range for 1000:1, VCG change (1200:1 for 12 MHz range).

Amplitude Range
0.01 to 10.2 Vp-p into termination matching output impedance (0.02 to 20.4 Vp-p into ≥50 kΩ). Units of measure are displayed in Vp-p, Vp, Vrms, or dBm (into selected Z).

DC Offset Range
−5.1V to +5.1V into termination matching output impedance (−10.2V to +10.2V into ≥50 kΩ). Absolute peak amplitude plus offset may not exceed 5.1V into termination matching output impedance (10.2V into ≥50 kΩ).

Outputs (Overload Protected)
Function Output: Source of primary waveforms. Source impedance is 50, 75 or 600Ω; user or option selected.* Peak output current is 100 mA max.
TTL Output: TTL compatible pulse with 50% duty cycle at selected frequency. Level is ≤0.4V to ≥2.0V into 50Ω, ≤0.4V to ≥4.0V into ≥50 kΩ.
ECL Output: Same characteristics as TTL output except levels are ECL compatible when loaded by 50Ω into −2V.

Inputs
VCG In: BNC input for voltage control of generator frequency in non-synthesized modes. Accepts up to ±12V into 10 kΩ.
Trig In: BNC input accepts TTL compatible signal to trigger or gate the generator. Positive or negative edge triggering or high or low level gating is selectable. External signal pulse width is 50 ns minimum with a maximum repetition rate of 5 MHz.
AM In: BNC input for external ac modulating signal for AM or suppressed carrier modulation (SCM) envelope. Accepts ±5V into 600Ω.

FREQUENCY PRECISION

Resolution
4 digits in synthesized modes. 3 digits in all other modes. Additional ¼ digit for frequencies above 10 MHz.

Accuracy
50 ppm in synthesized mode; in others, ±1% of setting ±1% of range.

Synthesized Mode Lock Time
<300 ms for within 0.01% of new programmed frequency.

Repeatability (24 hr)
0.0003% in synthesized mode. ±1% in all other modes.

Jitter
≤0.1% ±100 ps.

AMPLITUDE AND DC OFFSET PRECISION

Abs Pk Ampl + Offset	Ampl and Offset Resolution
>0.5V	3 digits or 10 mV
≤0.5V	3 digits or 1 mV
≤0.05V	3 digits or 0.1 mV

Amplitude Accuracy
±1% of selected value and:
±1 mV for 0.01 to 0.1Vp-p (peak amplitude + offset ≤0.05V).
±10 mV for 0,1 to 1Vp-p (peak amplitude + offset <0.5V).
±100 mV for 1.01 to 10.2Vp-p.

Offset Accuracy (In DC Function)
±1 mV for <50 mV.
±6 mV for ≥50 mV to <0.50V.
±60 mV for ≥0.50V.

Repeatability (24 hr)
Amplitude: ±1% ±10 mV.
Offset: ±1% ±20 mV.

Amplitude Flatness (50Ω)*
For 5 Vp-p sine wave: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz. Ref is 1 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion (THD at 5 Vp-p)
<0.5%, 0.01 Hz to 9.99 kHz, <1.0% 10.0 kHz to 99.9 kHz.
No Harmonics above:
−40 dBc, 100 kHz to 999 kHz,
−27 dBc, 1 MHz to 12 MHz (50Ω).*

Time Symmetry
±1% ±8 ns.

Square Transition Time (50Ω)*
<25 ns.

Square Pk-to-Pk Aberrations (50Ω)*
<4% at full amplitude.

Triangle Linearity
99% to 100 kHz.

Stability
Amplitude, Frequency (Non-synthesized) and DC Offset: (After 30 minute warm-up) ±0.10% of range for 10 minutes. ±0.50% of range for 24 hours.
Frequency (Synthesized): ±1 ppm/°C for 0 to 50°C. Crystal is 6.144 MHz with 0.005% accuracy and aging rate of 20 ppm/year.

Spurious Signals (At Func Out)
Typically 70 dB below fundamental to 1 MHz and 40 dB below fundamental to 12 MHz (in synthesizer mode only).

Integrated Signal to Phase Noise
Typically 40 dB below the signal to 1 MHz measured over ±15 kHz bandwidth excluding carrier ±10 Hz (in synthesizer mode only).

GENERAL

Environmental
Temperature Range: 23° ±5°C for specified operation, operates 0° to +50°C, −20° to +75°C for storage.
Warm-up Time: 20 minutes.
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 95% up to 60°C storage; operating 45% to 50°C and 75% to 25°C at sea level (non-condensing).
Vibration: 5 to 55 Hz. 2g at 55 Hz max.
Shock: 30g, 11 ms half sine.

Dimensions:
211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep.

Weight:
4.0 kg (8.8 lb) net; 5.0 kg (11 lb) shipping.

Power:
90 to 110, 105 to 125, 180 to 220, 210 to 250V, 48 to 66 Hz, less than 50 VA.

NOTE: All specifications apply for programmed amplitude of 10 Vp-p into 50Ω.

OPTIONS

001 GPIB Programming**
IEEE 488-1978 compatible. Non-isolated. Double buffered.
Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E1.
Address: 0-30, internally switched.

002 RS-232-C Serial Port**
DB-25 female connector. DCE or DTE config. Full duplex with CTS/DTR or XON/XOFF handshaking. Format is 8 bits with no parity and one stop bit. Data rate from 50 to 9600 Baud.

*Higher installed impedances will have derated high frequency performance subject to variation due to output cable lengths
**Factory Only Installation

FACTORY/FOB

San Diego, CA

PRICE

Model 23	**$1995**
Option 001 (GPIB)**	**$395**
Option 002 (RS232)**	**$395**
Option 003 (75Ω)	**NC**
Option 004 (600Ω)	**NC**

12 MHz Function Generator

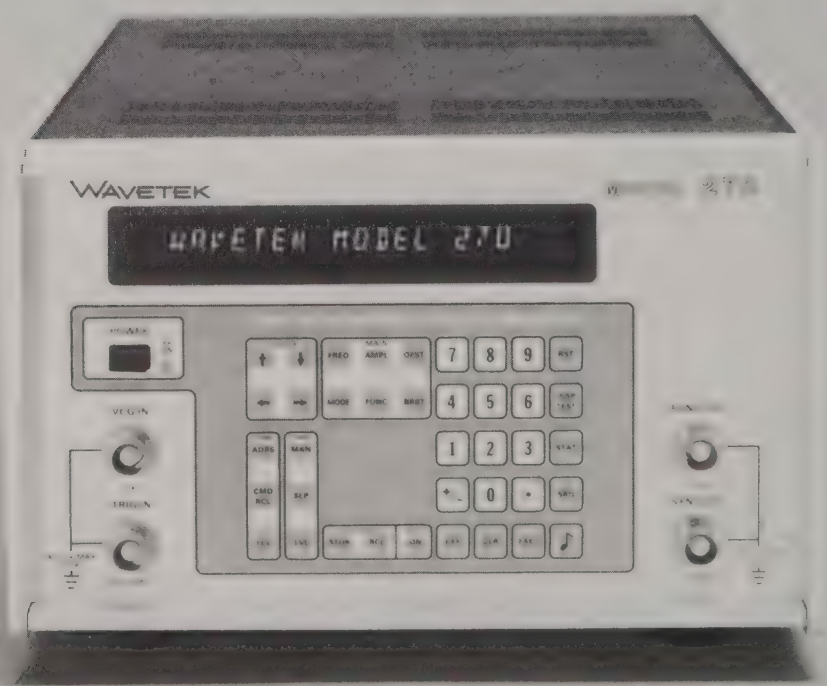
- **Half-Rack Width Package**
- **0.01 Hz to 12 MHz Frequency Range**
- **GPIB (IEEE 488) Standard**
- **200V Output Protection**
- **200 Stored Settings Standard**

Compact and Versatile
Model 270 Programmable Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 270 can generate precise sine, triangle, square, and external width controlled waveforms from 0.01 to 10 Vp-p, and dc offsets within a −5V to +5V range into 50Ω. Waveforms can be continuous, gated or triggered.

Easy to Program
The GPIB entry sequence is identical to front panel entry and the ASCII character, for GPIB programming, appears with each key on the front panel. This makes it easy to transfer a manual setup to a controller program and vice versa. To help the operator even more, "command recall" can display up to 40 previous characters entered either at the front panel or by GPIB. The 270 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

Protected Outputs
All 270 outputs are protected against short circuits and excessive voltages between ±15V. The main output is further protected against voltage inputs of up to 140 Vac or ±200 Vdc. If a voltage greater than ±15V is applied to the main output, the 270 generates an audible alarm, a front panel error message, and a GPIG service request. Inputs are protected from voltages up to ±50V.

Stored Settings
The 270 can store up to 200 complete operational settings in memory for fast recall. Battery backup is standard. In addition, stored setting 0 recalls the last executed setup of the instrument, even after the instrument has been turned off. A warning message will be displayed when the long-life, non-rechargeable battery needs to be replaced.



MODEL 270 PROGRAMMABLE FUNCTION GENERATORS

VERSATILITY

Waveforms
Programmable sine ∿, triangle △, square ⊓, square complement ⊔, external width or dc.

Operational Modes

Continuous: Output continuous at programmed frequency.

Triggered: Output quiescent until triggered by an external signal, GPIB trigger or manual trigger, then generates one cycle at programmed frequency.

Gated: As triggered mode except output oscillates for the duration of the gate signal. The last cycle started is completed.

Frequency Range
10 mHz to 12 MHz.

Outputs

Function Output: Waveforms from 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ). DC or offset programmable from −5V to +5V into 50Ω (−10V to +10V into ≥50 kΩ).

Programmable Control Provides:
Output On (50Ω source impedance);
Output Off, High Z (>500kΩ);
Output Off, Low Z (approx 50Ω termination).
Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).
Source Impedance: 50Ω.
Protection: Output protected to 140 Vac or ±200 Vdc without replacement of internal fuse.

Sync Output: TTL level square wave into 50Ω at programmed frequency.
TTL Compatible: ≤0.4V to ≥2.4V into 50Ω, ≤0.8V to ≥4.8V into ≥50 kΩ.
Source Impedance: 50Ω.
Timing: Concurrent with main output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Protection: Output protected against ±15V input minimum.

Inputs

VCG In: 0.01 to 12V into 10 kΩ, for up to 1200:1 frequency change. 10V gives range max. 12V gives 20% overrange. Slew Rate: 1V/μs.

Trig In: Level programmable: −10 to +10V, 20 mV resolution, ±500 mV accuracy. Programmable to trigger on − or + signal slope.
Impedance: 10 kΩ.
Maximum Rate: 12 MHz (24 MHz for External Width).
Minimum Width: 20 ns.
Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 24 MHz.

Protection: Inputs protected against ±50V input minimum.

PRECISION

Frequency
Resolution: 3 digits.
Accuracy: ±2%.
Repeatability: ±1% for 24 hr.
Jitter: ≤0.1% ±100 ps.

Amplitude
Resolution: 3 digits or 10 mV when absolute peak ampl plus offset >0.5V; 3 digits or 1 mV when absolute peak ampl plus offset ≤0.5V.
Accuracy: ±2% of programmed value and: ±5 mV for 0.1 to 1V (pk ampl + ofst <0.5V), ±20 mV for 1.01 to 10V, ±50 mV for all other.
Repeatability (24 hr): ±1% ±10 mV.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset
Resolution: 3 digits or 10 mV when absolute peak ampl plus offset >0.5V, 3 digits or 1 mV when absolute peak ampl plus offset ≤0.5V.
Accuracy: ±40 mV in DC function.
Repeatability (24 hr): ±1% ±20 mV.

Waveform Quality
Sine Distortion (at 5 Vp-p): THD <0.5%, 10 mHz to 99.9 kHz.
No Harmonics Above
−40 dBc, 100 kHz to 999 kHz.
−30 dBc, 1 MHz to 12 MHz.
Time Symmetry: ±1% ±8 ns.
Square Transition Time: <15 ns.
Square Over/Undershoot: <5% of pk-pk amplitude ±20 mV.
Triangle Linearity: 99% to 100 kHz.

GENERAL

GPIB Programming
IEEE 488-1978 compatible. Non-isolated. Double buffered.
Address: 0-30, keyboard or internal switch selectable. Internal switch can lock out keyboard selection. Power-up address is internal setting.
Subsets: SH1 Complete source handshake, AH1 Complete acceptor handshake, T6 Basic talker, TE0 No extended talker, L4 Basic listener, SR1 Complete service request (software selectable), RL1 Remote/local and local lockout, PP0 No parallel poll capability, DC1 Complete device clear/selective device clear, C0 No controller capability, E2 Tri-state drivers.

Interface Timing

Parameter	Time
Frequency	11 ms
Amplitude	14 ms
Offset	14 ms
Mode	4 ms
Waveform	5 ms
Execute	8 ms
Other	4 ms

Stored Settings
Nonvolatile memory for 200 stored settings. Battery back-up with minimum 6 mo. retention (typ. 5 yr.), battery check and status display.

Environmental
Temperature Range: 25°C ± 10°C for spec operation, operates 0°C to 50°C, −50°C to +75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 95% at 25°C and sea level (non-condensing).

Dimensions
21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.

Weight
5.9 kg (13 lb) net; 6.8 kg (15 lb) shipping.

Power
90 to 105, 108 to 126, 198 to 231, or 216 to 252 volts rms; 48 to 66 Hz; 1 phase; <40 watts.

OPTIONS

002: Rear Panel Connectors
Front panel BNCs relocated to rear panel.

003: Burst Option
Programmable number of waveform cycles in a burst.
Burst Length: 1,048,200 max.
Burst Rate: 12 MHz.

FACTORY/FOB

San Diego, CA

PRICE

Model 270	**$2600**
Option 002	**$125**
Option 003	**$295**

12 MHz Pulse/Function Generator

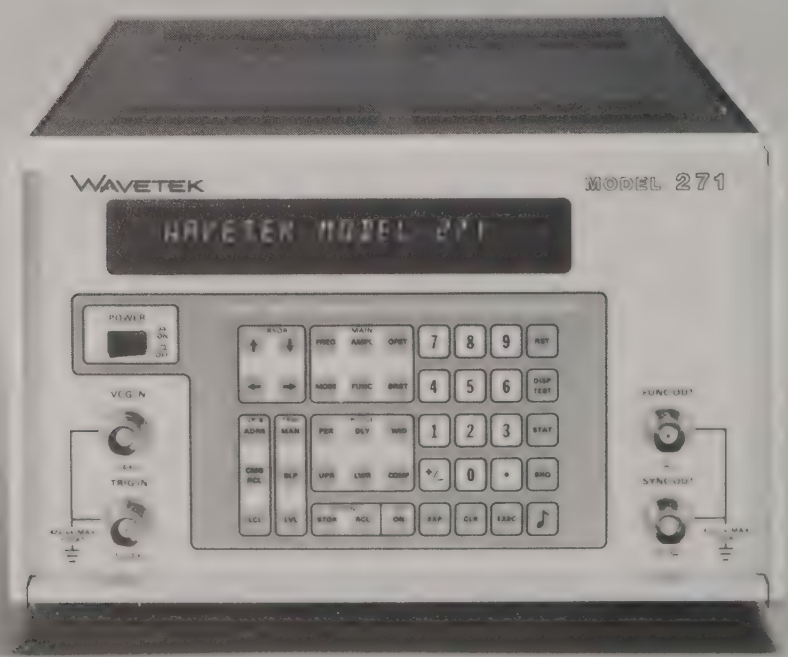
- 0.01 Hz to 12 MHz Frequency Range
- Pulse Delay, Width and Complement
- 1 to 1,048,200 Burst Count
- GPIB (IEEE 488) Standard
- 200V Output Protection

Compact and Versatile
Model 271 Programmable Pulse/Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 271 can generate precise sine, triangle, square, pulse, and external width controlled waveforms from 0.01 to 10 Vp-p, and dc offsets within a −5V to +5V range into 50Ω. Waveforms can be continuous, gated or triggered.

True Pulse Capability
The 271's pulse capability provides variable pulse delay from 80 ns to 0.1 sec, variable pulse width from 40 ns to 0.1 sec, and double pulse. All pulse functions may be complemented. For added convenience, period may be programmed rather than frequency, and upper and lower level rather than amplitude.

Ease of Programming
The GPIB entry sequence is identical to front panel entry and the ASCII character, for GPIB programming, appears with each key on the front panel. This makes it easy to transfer a manual setup to a controller program and vice versa. To help the operator even more, "command recall" can display up to 40 previous characters entered either at the front panel or by GPIB. The 271 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

Protected Outputs
All 271 outputs are protected against short circuits and external voltages between ±15V. The main output is further protected against voltage inputs of up to 140 Vac or ±200 Vdc. If a voltage greater than ±15V is applied to the main output, the 271 generates an audible alarm, a front panel error message, and a GPIB service request. Inputs are protected against voltages up to ±50V.



MODEL 271 PROGRAMMABLE FUNCTION GENERATORS

VERSATILITY

Waveforms
Programmable sine ∿, triangle ∿, square ⊓, square complement ⊓, external width pulse ⊓, double pulse ⊓⊓ or dc.

Operational Modes
Continuous: Output continuous.
Triggered: One cycle at programmed frequency when triggered by an external signal, GPIB or manually.
Gated: As triggered except output oscillates for the duration of the gate signal. Last cycle started is completed.
Burst: As Triggered except output oscillates for the number of cycles programmed into burst counter (1-1,048,200; burst rate 12 MHz max).

Frequency Range
10 mHz to 12 MHz.

Outputs
Function Output: Waveforms from 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ). DC or offset programmable from −5V to +5V into 50Ω (−10V to +10V into ≥50 kΩ). Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).
Programming: May be Vp-p and offset or upper and lower levels: lower from −5 to +4.99V into 50Ω, upper from −4.99 to +5V. Upper must be greater than lower.
Programmable Control Provides:
Output On (50Ω source impedance);
Output Off, High Z (>500kΩ);
Output Off, Low Z (approx 50Ω termination).
Source Impedance: 50Ω.
Protection: Output protected to 140 Vac or ±200 Vdc without replacement of internal fuse.
Sync Output: TTL level square wave: ≤0.4V to ≥2.4V into 50Ω, ≤0.8V to ≥4.8V into ≥50 kΩ.
Source Impedance: 50Ω.
Timing: Concurrent with main output in square; lags sine and triangle by 90°.
Protection: Output protected against ±15V input minimum.

Inputs
VCG In: 0.01 to 12V into 10 kΩ, for up to 1200:1 frequency change. 10V gives range max, 12V gives 20% overrange. Slew Rate: 1V/μs.
Trig In: Level programmable: −10 to +10V, 20 mV resolution, ±500 mV accuracy. Programmable to trigger on − or + signal slope.
Impedance: 10 kΩ.
Maximum Rate: 12 MHz (15 MHz in External Width).
Minimum Width: 20 ns.
Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 24 MHz.
Protection: Inputs protected against ±50V input minimum.

Pulse
Delay: 80 ns to 0.1 sec. Measured from 1.25V point of leading edge of sync (into 50Ω load) to leading corner of main output pulse. (In double pulse, to second pulse of pulse pair.)
Width: 40 ns to 0.1 sec. Measured from 50% of leading edge to 50% of trailing edge.
Delay/Width Duty Cycle:
50% when delay/width <500 ns.
80% when delay/width ≥500 ns.
Normal/Complementary: All pulses may be complemented. Sine, triangle and square outputs cannot be complemented.

PRECISION

Frequency
Resolution: 3 digits.
Accuracy: ±2%.
Repeatability (24 hr): ±1%.
Jitter: ≤0.1% ±100 ps.

Amplitude
Resolution: 3 digits or 10 mV when absolute peak ampl plus offset >0.5V; 3 digits or 1 mV when absolute peak ampl plus offset ≤0.5V.
Accuracy: ±2% of programmed value and: ±5 mV for 0.1 to 1V (pk ampl + ofst <0.5V), ±20 mV for 1.01 to 10V, ±50 mV for all other.
Repeatability (24 hr): ±1% ±10 mV.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset
Resolution: 3 digits or 10 mV when absolute peak ampl plus offset >0.5V, 3 digits or 1 mV when absolute peak ampl plus offset ≤0.5V.
Accuracy: ±40 mV in DC function.
Repeatability (24 hr): ±1% ±20 mV.

Pulse Delay and Width
Resolution: 3 digits.
Accuracy: ±3% of programmed value ±10 ns.
Repeatability (24 hr): ±1% ±3 ns.

Waveform Quality
Sine Distortion (at 5 Vp-p): THD
<0.5% 10 mHz - 99.9 kHz
No Harmonics Above:
<−40 dBc 100 kHz - 999 kHz
<−30 dBc 1 MHz - 12 MHz
Time Symmetry: ±1% ±8 ns.
Square Transition Time: <15 ns.
Square Over/Undershoot: <5% of pk-pk amplitude ±20 mV.
Triangle Linearity: 99% to 100 kHz.

GENERAL

Stored Settings
Nonvolatile memory for 150 stored settings. Battery back-up with minimum 6 mo. retention (typ. 5 yr.), battery check and status display.

GPIB Programming
IEEE 488-1978 compatible. Non-isolated. Double buffered.
Address: 0-30, keyboard or internal switch selectable. Internal switch can lockout keyboard selection. Power-up address is internal setting.
Subsets: SH1 Complete source handshake, AH1 Complete acceptor handshake, T6 Basic talker, TE0 No extended talker, L4 Basic listener, SR1 Complete service request (software selectable), RL1 Remote/local and local lockout, PP0 No parallel poll capability, DC1 Complete device clear/selective device clear, C0 No controller capability, E2 Tri-state drivers.

Interface Timing

Parameter	Time
Frequency	11 ms
Amplitude	14 ms
Offset	14 ms
Mode	4 ms
Waveform	5 ms
Execute	8 ms
Other	4 ms

Environment
Temperature Range: 25°C ± 10°C for spec operation, operates 0°C to 50°C; −50°C to +75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 95% at 25°C and sea level (non-condensing).

Dimensions
21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.

Weight
5.9 kg (13 lb) net; 7.3 kg (16 lb) shipping.

Power
90 to 105, 108 to 126, 198 to 231, or 216 to 252 Vrms; 48 to 66 Hz; 1 phase; <40 watts.

OPTIONS

002: Rear Panel Connectors
BNCs relocated to rear panel.

FACTORY/FOB

San Diego, CA

PRICE

Model 271	**$2995**
Option 002	**$125**

12 MHz Sweep/Function Generator

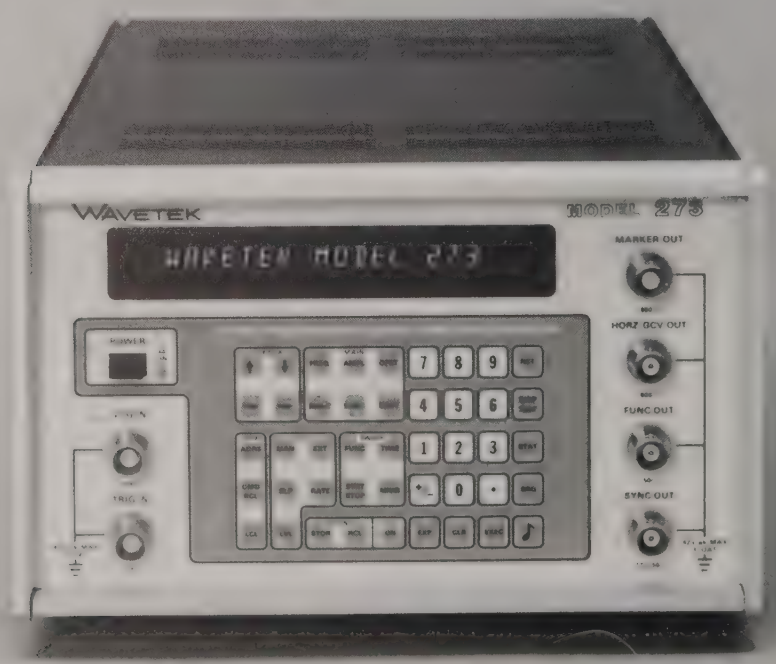
- **User Definable Sweep Shape**
- **Six Standard Sweep Shapes**
- **Twelve Sweep Modes**
- **Three Frequency Markers**
- **GPIB (IEEE-488) Standard**

Compact and Versatile
Model 273 Programmable Sweep/Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 273 can generate precise sine, triangle and square waveforms from 0.01 to 10 Vp-p, and dc offsets within a −5 to +5V range into 50Ω. Waveforms can be continuous, gated, triggered or burst; all waveforms may be swept.

Exceptional Sweep Capability
Up to 1200:1 sweep range, 12 sweep modes and 6 standard sweep shapes (plus your own GPIB programmable sweep shape) provide exceptional sweep capabilities in a programmable function generator. Three simultaneous, active markers are available with polarity selection. Sweep start and stop frequencies are easily programmed with a front panel key or GPIB.

Ease of Programming
The GPIB entry sequence is identical to front panel entry and the ASCII character for GPIB programming appears on most keys on the front panel. This makes it easy to transfer a manual setup to a controller program or vice versa. To help the operator even more, "command recall" can display up to 40 previous characters entered either at the front panel or via the GPIB. The 273 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

Protected Outputs
All 273 outputs are protected against short circuits and excessive voltages between ±15V. The main output is further protected against voltage inputs of up to 140 Vac or ±200 Vdc. If a voltage greater than ±15V is applied to the main output, the 273 generates an audible alarm, a front panel error message, and a GPIB service request.

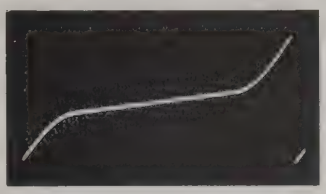


User Defined Sweep Function
This feature allows you to define your own unique sweep shape. It provides you with a 12 bit by 1K memory and is programmable over the GPIB.

Example of "User Defined" Sweep

Applications: This capability is very useful in such applications as tone testing, digital frequency modulation, vibration testing and providing trigger signals to measurement devices.

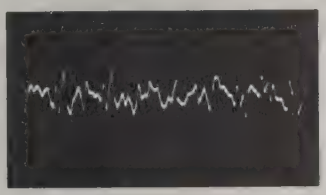
Filter Sweep Function
Provides a slower sweep rate near the mid-frequency point for higher resolution when sweeping high-Q circuits.



Filter Sweep Function

Applications: This sweep shape can save you valuable time when testing very narrow filters where the sweep must be slowed dramatically in order to describe the characteristics.

Noise Sweep Function
A noise pattern with a Gaussian distribution characteristic is used to FM modulate the generator signal.

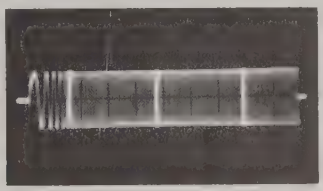


Noise Sweep Function

Applications: Jitter testing is greatly simplified when using this mode. The built-in pseudo-random noise pattern allows you to test for FM noise rejection and jitter susceptibility.

Other Sweep Functions
Linear, Logarithmic, Sine and Square.

Frequency Markers
Three simultaneous, individually programmable frequency markers are present at the Marker Output. These selectable polarity markers allow convenient identification of filter center frequency and upper and lower cutoff frequencies. Up to 500 markers can be generated with the *User Defined* sweep shape.



Swept Waveform with Markers

WAVEFORMS (FUNCTIONS)

Programmable sine ∿, triangle △, square ⊓, external width, and dc.
Sine Distortion (THD at 5 Vp-p): <0.5% 10 mHz to 99.9 kHz. No harmonics above −40 dBc 100 kHz to 999 kHz, −30 dBc 1 MHz to 12 MHz.
Time Symmetry: ±1% ±8 ns.
Square Transition Time: <15 ns.
Square Overshoot: <4% at full amplitude.
Triangle Linearity: 99% to 100 kHz.

OPERATIONAL MODES

Continuous: Output continuous at programmed frequency.
Triggered: Output quiescent until triggered by internal or external signal, GPIB trigger or manual trigger, then generates one cycle at programmed frequency.
Gated: As triggered mode except output is continuous for the duration of the gate signal. The last cycle started is completed.
Burst: As triggered mode for programmed number of cycles.
Count Range: 1 to 1,048,200.
Burst Rate: 12 MHz maximum.

FREQUENCY

Range: 10 mHz to 12 MHz (>15 MHz in external width mode).
Resolution: 3 digits.
Accuracy: ±2%.
Repeatability (24 hr): ±1%.
Jitter: ≤0.1% ±100 ps.
Control: Frequency may be controlled by programmed value or external VCG input.
Value: Frequency value is keyboard or GPIB programmable with automatic range selection.
VCG (Voltage Controlled Generator): AC or dc input controls frequency. +0.01 to +12V into 10 kΩ for up to 1200:1 frequency change in each of 9 frequency ranges (ranges must be programmed). Slew rate is limited to 1V/μs.

AMPLITUDE

Range: 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ) from main output Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V; 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V
Accuracy: ±2% of programmed value and: ±5 mV for 0.1 to 1V (peak amplitude + offset <0.5V), ±20 mV for 1.01 to 10V, ±50 mV for all other.
Repeatability (24 hr): ±1% ± 10 mV.
Flatness (At 5 Vp-p): 0.1 dB to 100 kHz, 1.5 dB to 12 MHz.

OFFSET

Range: DC or offset programmable from −5V to +5V into 50Ω (−10V to +10V into ≥50 kΩ). Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V, 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V
Accuracy: ±40 mV in dc function
Repeatability (24 hr): ±20 mV

OUTPUTS

Function Output: Source of primary waveforms.
Programmable Control Provides:
Output On, (50Ω source impedance);
Output Off, High Z (>500 kΩ);
Output Off, Low Z (approximately 50Ω termination).
Source Impedance: 50Ω
Protection: Output protected to 140 Vac or 200 Vdc without internal damage.
Sync Output: Sync signal is at programmed frequency and TTL level

Level: ≤0.4V to ≥2.4V into 50Ω, ≤0.8V to ≥4.8V into ≥50 kΩ.
Source Impedance: 50Ω.
Timing: Concurrent with function output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Protection: Output protected from short circuit to any voltage between ±15 Vdc input minimum.

INPUTS

External Trigger: Trigger of input circuit is programmable for a + or − signal slope and required threshold level.
Level: −10 to +10V.
Resolution: 20 mV.
Accuracy: ±500 mV.
Input Impedance: 10 kΩ.
Maximum Trigger Rate: 12 MHz (15 MHz for External Width).
Minimum Trigger Width: 40 ns.
Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 15 MHz.
VCG In: Voltage control of generator frequency. See frequency.
Range: 0.01 to 12V.
Impedance: 10 kΩ.
Protection: Inputs protected to ±50V.

INTERNAL TRIGGER

Range: 0.0025 Hz to 2.5 MHz.
Resolution: 4 digits.
Accuracy: 0.2%.

SWEEP MODES

Continuous Sweep and Reset

Main generator sweeps from start frequency to stop frequency, resets to start frequency and continues.

Continuous Sweep and Reverse

Main generator sweeps from start frequency to stop frequency, reverse sweeps to start frequency and continues.

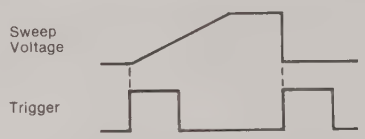
Triggered Sweep and Reset

When triggered, main generator sweeps from start frequency to stop frequency and resets to start frequency until next trigger.

Triggered Sweep and Reverse

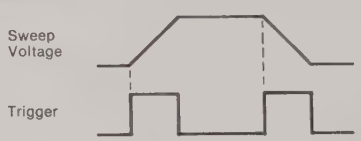
When triggered, main generator sweeps from start frequency to stop frequency, reverse sweeps to start frequency and remains until next trigger.

Triggered Sweep and Hold with Triggered Reset



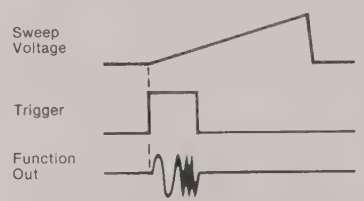
When triggered, main generator sweeps from start frequency to stop frequency until next trigger. When triggered again, resets to start frequency and remains.

Triggered Sweep and Hold with Triggered Reverse



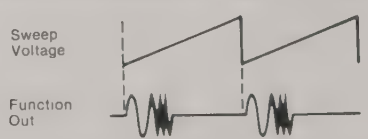
When triggered, main generator sweeps from start frequency to stop frequency. When triggered again, main generator reverse sweeps to start frequency.

Triggered Sweep and Reset with Burst



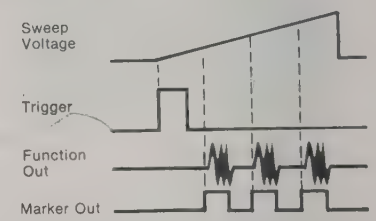
Main generator quiescent until triggered. When triggered, sweep and programmed burst counter run simultaneously for programmed number of waveform cycles. Output quiescent upon completion of cycle count.

Continuous Sweep and Reset with Burst



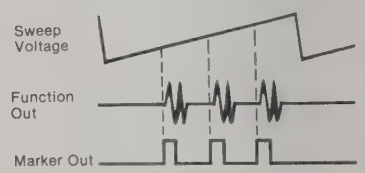
Main generator sweeps from start frequency to stop frequency, resets to start frequency and continues. Start of sweep triggers burst counter. Main generator output is quiescent until triggered by the start of sweep, and returns to quiescent state after completion of programmed number of cycles.

Triggered Sweep and Reset with Burst on Markers



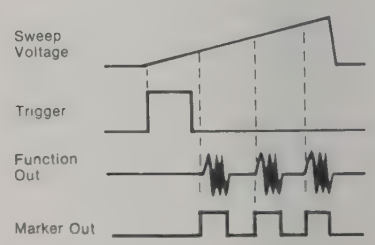
When triggered, main generator sweeps from start frequency to stop frequency , resets and is held until next trigger. Main generator output is quiescent until triggered by markers and returns to a quiescent state after completion of the programmed number of cycles.

Continuous Sweep and Reset with Burst on Markers



Main generator sweeps from start frequency to stop frequency, resets to start frequency and continues. Burst counter is triggered by markers. Main generator output is quiescent until triggered by markers and returns to a quiescent state after completion of programmed number of cycles.

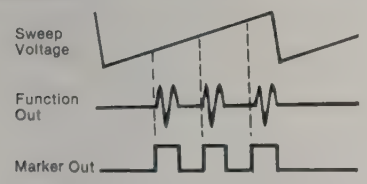
Triggered Sweep and Reset with Gate on Markers



When triggered, main generator sweeps from start frequency to stop frequency, resets to start frequency and is held until next trigger. Main generator output is quiescent until gated on by markers going high, and returns to a quiescent state when markers are low.

MODEL 273 PROGRAMMABLE FUNCTION GENERATORS

Continuous Sweep and Reset with Gate on Markers



Main generator sweeps from start frequency to stop frequency, resets to start frequency and continues. Main generator output is quiescent state when markers are low.

SWEEP CHARACTERISTICS

Sweep Time: 400μs to 400,000s, 3 digits resolution, 0.2% accuracy.
Start/Stop: Maximum ratio 1200:1. Both start and stop frequency must be contained within a single sweep range. Sweep ranges are listed below.
Markers: 0.01 Hz to 12 MHz, 3 digits resolution, 3% of programmed value + 0.2% of top of sweep range selected.

Sweep Ranges

10 mHz	—	12 Hz
100 mHz	—	120 Hz
1 Hz	—	1.2 kHz
10 Hz	—	12 kHz
100 Hz	—	120 kHz
1 kHz	—	1.2 MHz
1 kHz	—	12 MHz

SWEEP OUTPUTS

Marker Output: Three independent, simultaneously active markers. 0 to 5V into 600Ω. Programmable polarity control: RCL 4000 EXEC initiates positive marker, RCL 4001 EXEC initiates negative marker.
Horizontal Output: 0 to + 5V ± 5%. 250 point synthesized ramp. 600Ω source impedance. RCL 3000 EXEC initiates Horizontal Out.
GCV Output: 0 to + 6V ± 10%. 1000 point synthesized GCV the same wave shape as that sweeping the main generator. Source impedance: 600Ω. RCL 3001 EXEC initiates GCV. GCV output voltage level is proportional to main generator frequency.
Protection: Output protected against ± 15V input minimum.

SWEEP FUNCTIONS

Linear: Linear variation of frequency with respect to time during active sweep.
Log: Logarithmic variation of frequency with respect to time during active sweep.
Sine: Sinusoidal variation of frequency with respect to time. Sweeps from − 90° to + 90°.
Square: Impulse variation of frequency between start and stop during active sweep.
Noise: Pseudo-randomized Gaussian variation of frequency between start and stop during active sweep. Start and stop are 2.5 standard deviations from midfrequency point.
Filter: Sweep rate slows towards midfrequency point allowing higher resolution.
User Defined: User programmable variation of frequency between start and stop during active sweep. Unique user defined sweep function is stored in nonvolatile memory.

GPIB PROGRAMMING

IEEE 488-1978 compatible. Non-isolated. Double buffered.
Address: 0—30, keyboard or internal switch selectable. Internal switch can lock out keyboard selection. Power-up address is internal setting.
Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.

Interface Timing:

Frequency	16 ms
Amplitude	13 ms
Offset	14 ms
Mode	6 ms
Function	5 ms
INT/EXT	5 ms
Execute	20 to 500 ms
Store	11 ms
Output	10 ms
Slope	5 ms
Burst Count	10 ms
Rate	35 ms
Recall	185 ms
Reset	185 ms

GENERAL

Stored Setting: Non-volatile memory will store 25 settings.
Environment:
Temperature Range: 25°C ± 10°C for specified operation; operates 0°C to 50°C; − 50°C to + 75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 95% at 25°C and at sea level (non-condensing).
Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.
Weight: 5.9 kg (13 lb) net; 7.2 kg (16 lb) shipping.
Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 volts rms; 48 to 66 Hz; 1 phase; <40 watts.

OPTIONS

002: Rear Panel Connectors: Front panel BNCs relocated to rear panel.

ACCESSORIES

Style 12: Single Rack Adapter Kit: Allows any 270 series instrument to be right or left mounted in a standard 19 inch rack. 5¼ inches high.
Style 13: Dual Rack Adapter Kit: Allows any 270 series instrument to be mounted side-by-side in a standard 19 inch rack. 5¼ inches high.

FACTORY/FOB

San Diego, CA

PRICE

Model 273	**$3295**
Option 002	**$125**
Style 12	**$75**
Style 13	**$125**

12 MHz Synthesized Function Generator

- 0.01 Hz to 12 MHz Frequency Range
- 0.0005% Synthesized Accuracy
- Pulse Capability
- GPIB (IEEE 488) Standard
- 200V Output Protection

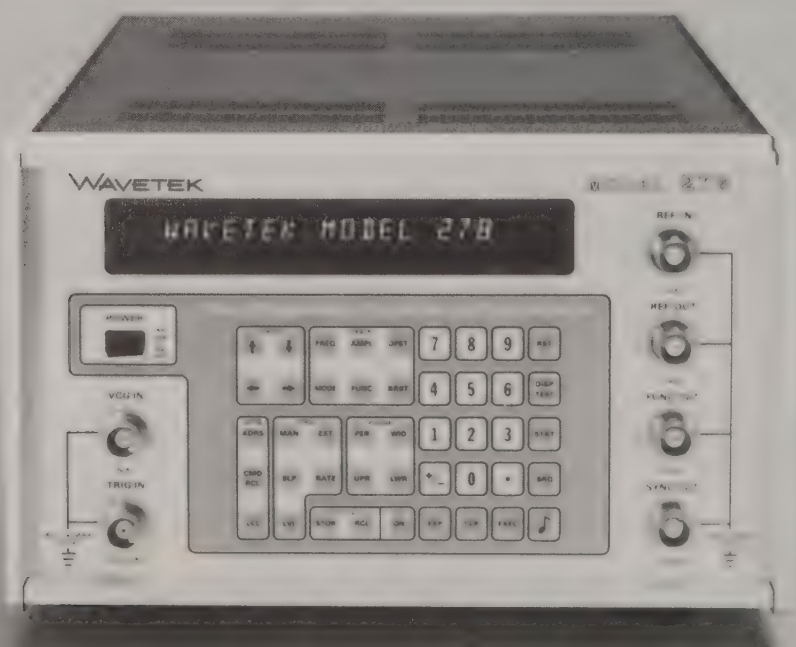
Compact and Versatile
Model 278 Programmable Synthesized Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 278 can generate precise sine, triangle, square, pulse, and external width controlled waveforms from 0.01 to 10 Vp-p, and dc offsets within a −5 to +5V range into 50Ω. Waveforms can be continuous, gated, or triggered.

Synthesized Accuracy
The 278's synthesized mode has 5 digit frequency resoution with 0.0005% accuracy, or it can be locked to an external 10 MHz frequency standard for even greater accuracy and stability. Other 278 features include phase locking to an external frequency and use of the synthesizer circuit as a highly accurate internal trigger.

Programmable Pulse Widths
The 278 can function as a pulse generator with pulse widths programmable from 45 ns to 500 ms with 2 digits of resolution. To make its use as a pulse generator more versatile, the 278 can also program upper and lower levels rather than amplitude and offset, and periods from 90 ns to 1 sec with 3 digits of resolution.

Ease of Programming
The GPIB entry sequence is identical to front panel entry and the ASCII character for GPIB programming appears with each key on the front-panel. This makes it easy to transfer a manual setup to a controller program or vice versa. To help the operator even more, "command recall" can display up to 40 previous characters entered either at the front panel or by GPIB. The 278 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

Protected Outputs
All 278 outputs are protected against short circuits and excessive voltages between ±15V. The main output is further protected against voltage inputs of up to 140 Vac or ±200 Vdc. If a voltage greater than ±15V is applied to the main output, the 278 generates a audible alarm, a front panel error message, and a GPIB service request. Inputs are protected from voltages up to ±50V.



MODEL 278 PROGRAMMABLE FUNCTION GENERATORS

VERSATILITY

Waveforms
Programmable sine ∿, triangle △, square ⊓, square complement ⊔, pulse ⊓, pulse complement ⊔, external width, or dc.

Operational Modes
Continuous: Nonsynthesized.
Triggered: One cycle triggered by external signal, GPIB, manual, or internal 1 Hz to 12 MHz rate (to 24 MHz in external width).
Gated: As Triggered except output continuous for duration of gate signal. Internal gate signal produces 50% duty cycle gate.
Burst: As Triggered for programmed number of cycles (1 - 1,048,200).
Synthesizer: As Continuous with increased freq accuracy and stability.
External Reference: As Synth plus locked to external 10 MHz ref.
External Phase Lock: As Continuous with output signal locked to external 10 Hz to 12 MHz signal.

Frequency Range
10 mHz to 12 MHz except 10 Hz minimum in Synth, Ext Ref and Ext Lock modes.

Outputs
Function Output: Waveforms from 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ). DC or offset from −5V to +5V into 50Ω (−10V to +10V into ≥50 kΩ). Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).
Source Impedance: 50Ω
Programmable Control Provides:
Output On, (50Ω source impedance);
Ouput Off, High Z (>500kΩ)
Output Off, Low Z (approx 50Ω termination).
Sync Output: TTL level square wave into 50Ω. 50Ω source impedance. Concurrent with main output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Ref Out: TTL level pulse. Frequency of internal trigger when in Trig, Gate, Burst or Pulse modes; 10 MHz in Ext Ref or Synth modes.
Protection: Sync and Ref outputs protected against ±15V input minimum. Function output protected to 140 Vac or ±200 Vdc without replacement of internal fuse.

Inputs
VCG In: 0.01 to 12V into 10 kΩ for up to 1200:1 frequency change. 10V gives range max. 12V gives 20% over range. Slew Rate: 1V/μs.
Trig In: Level programmable: −10 to +10V, 20 mV resolution, ±500 mV accuracy. Programmable to trigger on + or − signal slope.
Max Rate: 12 MHz (15 MHz in external width). Min Width: 20 ns. Min. Ampl: 500 mVp-p to 1 MHz, 1 Vp-p to 24 MHz. Impedance: 10 kΩ.
Ref In: TTL or 1 Vp-p min (select TTL or zero crossing). 10 MHz for Ext Ref mode; 10 Hz to 12 MHz for Phase Lock mode (capture and lock range >5% of programmed frequency).
Protection: Inputs protected against ±50V input minimum.

PRECISION

Frequency
Resolution: Synth and Ext Ref Modes: 5 digits.
All Other Modes: 3 digits.
Accuracy: Synthesizer Mode: 5 ppm ±1 mHz.
Ext Ref and Lock Modes: Accuracy of external ref signal ±1 mHz.
All Other Modes: ±2%.
Noise Floor: >−50 dBc.
Spurious: >−45 dBc.

Amplitude
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V; 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V.
Accuracy: ±2% of programmed value and: ±5 mV to 0.1 for 1V (pk ampl + ofst <0.5V), ±20 mV for 1.01 to 10V, ±50 mV for all other.
Repeatability (24 hr): ±1% ±10 mV.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V, 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V.
Accuracy: ±40 mV in DC function.
Repeatability (24 hr): ±1% ±20 mV.

Waveform Quality
Sine Distortion (at 5 Vp-p): THD <0.5%, 10 mHz to 99.9 kHz.
No Harmonics Above:
−40 dBc, 100 kHz to 999 kHz.
−30 dBc, 1 MHz to 12 MHz.
Time Symmetry: ±1% ±5 ns.
Square Transition Time: <15 ns.
Square Over/Undershoot: <5% of pk-pk amplitude ±20 mV.
Triangle Linearity: 99% to 100 kHz.

Internal Trigger Rate
Resolution: 5 digits.
Accuracy: 5 ppm + 1 mHz.
Range: 1 Hz to 12 MHz (24 MHz in external width).

Pulse Period
Resolution: 3 digits.
Accuracy: 0.1%.
Range: 90 ns to 1 sec.

Pulse Width
Duty Cycle: ≤50%.
Resolution: 2 digits.
Accuracy: 3% from 500 ns to 500 ms, 5% from 45 ns to 490 ns.
Range: 45 ns to 500 ms.

GENERAL

Stored Settings
Nonvolatile memory for 100 stored settings. Battery back-up with minimum 6 mo. retention (typ. 5 yr.), battery check and status display.

GPIB Programming
IEEE 488-1978 compatible. Non-isolated. Double buffered.
Address: 0-30 keyboard or internal switch selectable. Internal switch can lockout keyboard selection. Power-up address is internal setting.
Subsets: SH1, TE0, RL1, AH1, L4, PP0, C0, T6, SR1, DC1 and E2.

Interface Timing

Parameter	Time
Frequency	11 ms
Amplitude	14 ms
Offset	14 ms
Mode	4 ms
Waveform	5 ms
Execute	8 ms
Other	4 ms

Environment
Temperature Range: 25°C ± 10°C for spec operation, operates 0°C to 50°C, −50°C to +75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Operates 0 to 10,000 ft, 0 to 40,000 ft for storage.
Relative Humidity: 95% at 25°C and sea level (non-condensing).

Dimensions
21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.

Weight
5.9 kg (12.9 lb) net; 7.3 kg (16 lb) shipping.

Power
90 to 105, 108 to 126, 198 to 231, or 216 to 252 Vrms; 48 to 66 Hz; 1 phase; <50 watts.

OPTIONS

002: Rear Panel Connectors
BNCs relocated to rear panel.

FACTORY/FOB

San Diego, CA

PRICE

Model 278	**$3350**
Option 002	**$125**

12 MHz Arbitrary/ Function Generator

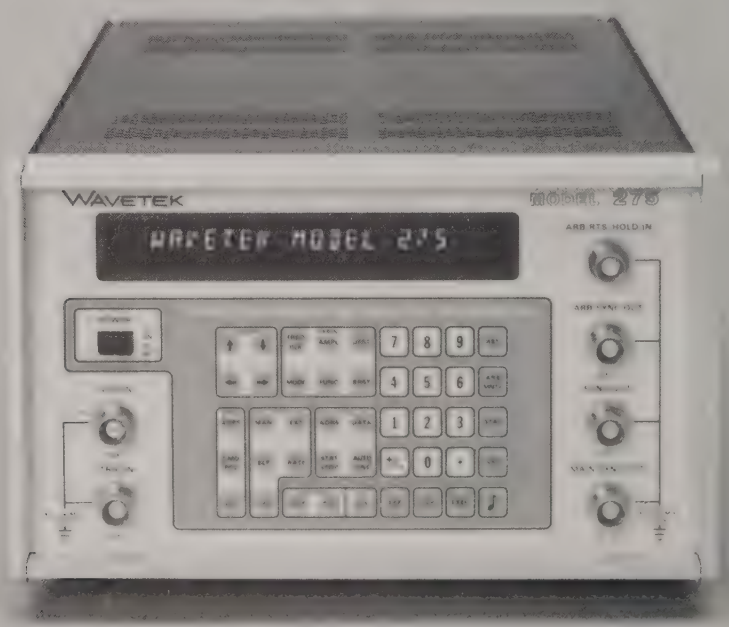
- **User Defined Wave Shapes**
- **12 Bit Amplitude Resolution**
- **Up to 8K Horizontal Points**
- **267 ns to 267s Clock Speed**
- **GPIB (IEEE-488) Standard**

Compact and Versatile
Model 275 Programmable Arbitrary/ Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 275 can generate precise sine, triangle, square and user-defined arbitrary waveforms from 0.01 to 10 Vp-p, and dc offsets within a −5 to +5V range into 50Ω. Waveforms can be continuous, gated, triggered or burst. Eleven useful modes include arbitrary waveform hold and ramp-to-start.

User Defined Waveforms
Any regular or irregular waveform may be easily entered into nonvolatile memory with the front panel keyboard or via GPIB. The auto-line feature greatly simplifies entry of waveforms consisting of straight line segments. Enter the line segment end points and program the auto-line command, and the internal microprocessor will automatically compute and store the data values for the remainder of the line segment.

12 Bit Amplitude Resolution
In the ARB modes, 12 bits of amplitude resolution provide unparalleled waveform resolution. Waveforms may be stored in full or partial blocks of 2 to 8,192 horizontal points. Clock speeds from 267 ns to 267 seconds per point provide waveform periods as long as 25 days.

Ease of Programming
The GPIB entry sequence is identical to front panel entry and the ASCII character for GPIB programming appears on most keys on the front panel. This makes it easy to transfer a manual setup to a controller program or vice versa. To help the operator even more, "command recall" can display up to 40 previous

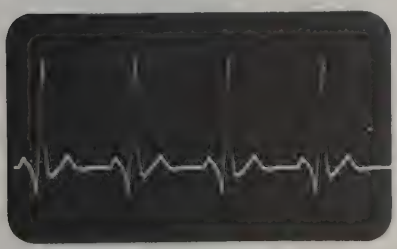


characters entered either at the front panel or by the GPIB. The 275 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

Protected Outputs
Model 275 outputs are protected against short circuits and external voltages between ± 15V. The main output is further protected against voltage inputs of up to 140 Vac or ± 200 Vdc. If a voltage greater than ± 15V is applied to the main output, the 275 generates an audible alarm, a front panel error message, and a GPIB service request.

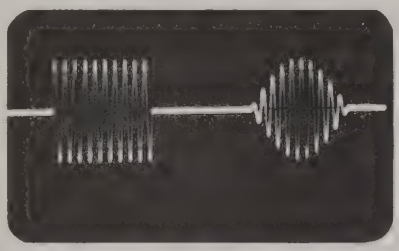
ARB Applications

Medical. Production and R&D applications for the 275 include testing of pacemakers and other medical equipment and simulation of heartbeats, nerve responses, and EEG brainwave patterns. The high resolution of the 275 along with the ability to vary the time between waveforms make it particularly useful in these applications.



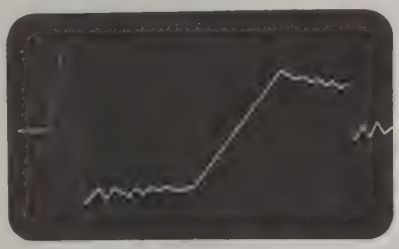
Heartbeat Simulation

Doppler. Doppler applications include underwater sound (sonar), radar IF strips, and ultra-sound (used in mechanical defect testing and medical testing). The ability of the 275 to vary time between waveforms (using the trigger-and-hold-on-breakpoint mode and internal triggering) with the cursor makes it ideal for these kinds of applications.



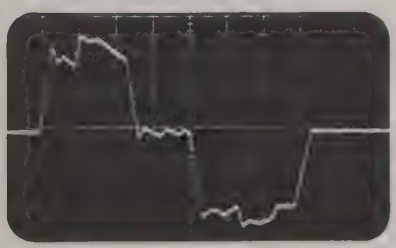
Simulated Doppler Signals

Material Testing. Material testing is a traditional application for ARB geneators. Ramp-to-start, hold-on-trigger, panel lockout, and ARB monitor features make the 275 more useful than previous ARB's for this application.



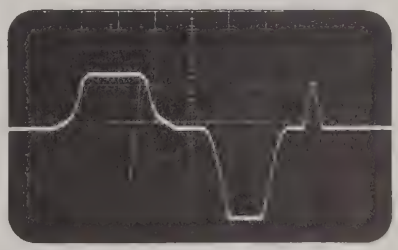
Typical Material Testing Waveform

Electromechanical Switching. Simulation of switcher motors, solenoids and relays require special waveforms which simulate contact bounce. The Model 275 has been used to generate these special types of waveforms.



Contact Bounce Simulation

Computer Disc. Computer peripherals such as disc drives and high speed printers require complex mechanical/electrical interfaces to insure proper alignments for proper data transfer. Disc drive manufacturers are using a modulated magnetic pickup technique to locate certain sync points on the spinning disc platter. The ARB simulates the spinning disc by providing the necessary sync waveforms to the pickup amplifiers. Flexibility of the ARB permits precise timing of waveforms through external triggering, as well as full level control and waveform switching. In the past, initial tune-up of these pickup amplifiers was hazardous, since an actual disc spinning at full speed was required for this precision work.



Typical Disc Sync Waveform

WAVEFORMS (FUNCTIONS)

Programmable sine ∿, triangle ∿, square ⊓, square comp, dc, external width, arbitrary and filtered arbitrary.

Sine Distortion (THD at 5 Vp-p)
<0.5% 10 mHz to 99.9 kHz. No harmonics above −40 dBc 100 kHz to 999 kHz, −30 dBc 1 MHz to 12 MHz.

Time Symmetry
±1% ±8 ns.

Square Transition Time
<15 ns.

Square Overshoot
<4% at full amplitude.

Triangle Linearity
99% to 100 kHz.

OPERATIONAL MODES (FOR ALL FUNCTIONS INCLUDING ARB)

Continuous
Output continuous at programmed frequency.

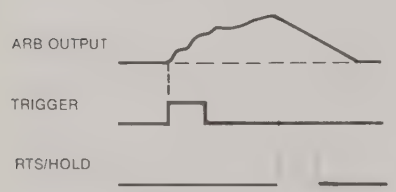
Triggered
Output quiescent until triggered by internal or external signal, GPIB trigger or manual trigger, then generates one cycle at programmed frequency or clock rate.

Gated
As triggered mode except output is continuous for the duration of the gate signal. The last cycle started is completed.

Burst
As triggered mode for programmed number of cycles.
Count Range: 1 to 1,048,200.
Burst Rate: 12 MHz maximum.

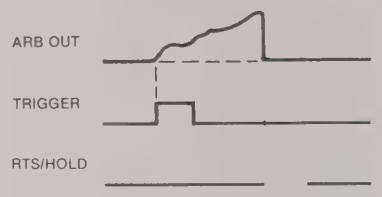
OPERATIONAL MODES (ARB ONLY)

Triggered ARB with Ramp-to-Start
One cycle of ARB waveform is initiated on first trigger input. Second trigger (at TRIG IN or ARB RTS/HOLD IN) causes ARB output to slowly ramp to start address of ARB waveform. If return-to-start (RTS) trigger is not received before stop address is reached, RTS is initiated at stop address.



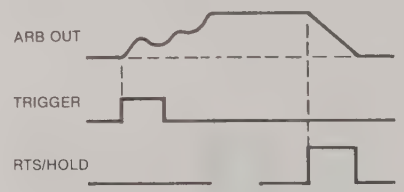
Triggered ARB with Ramp-to-Start

Triggered ARB with Reset
Same as *Triggered ARB with Ramp-To-Start* except the second trigger (or stop address) causes immediate reset to start address.



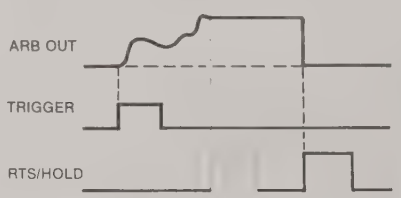
Triggered ARB with Reset

Triggered ARB with Hold and Triggered Ramp-to-Start
One cycle of ARB waveform is initiated on first trigger input. Second trigger causes ARB to hold. Third trigger causes ramp-to-start. If stop address is reached before second trigger then stop address causes hold and next trigger causes RTS.



Triggered ARB with Hold and Triggered Ramp-to-Start

Triggered ARB with Hold and Triggered Reset
One cycle of ARB waveform is initiated on first trigger input. Second trigger causes ARB to hold. Third trigger causes immediate reset to start. If stop address is reached before second trigger, then stop address causes hold and next trigger causes reset.

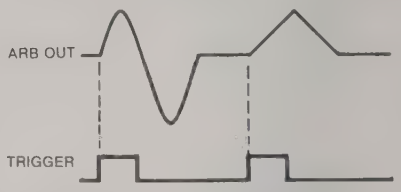


Triggered ARB with Hold and Triggered Reset

Single Step
Same as *Continuous* mode except when Arbitrary function is selected, ARB clock rate is replaced by trigger input so that ARB clock can be supplied externally or with function generator.

Examine
When Arbitrary function is selected, output will be voltage (data value) present at address specified on address program. This allows ARB waveform to be examined one point at a time by specifying address of desired point.

Triggered ARB with Hold on Breakpoint
ARB waveform is initiated upon trigger input and held at programmed breakpoints. Each successive trigger then causes the instrument to advance to the next breakpoint. Start and stop addresses are ignored in this mode after the first trigger.



Triggered ARB with Hold on Break Point

FREQUENCY

Range
10 mHz to 12 MHz for sine, triangle, square, square complement. >15 MHz for external width. ARB range dependent upon clock rate and block size. Clock rate 267 ns to 267s.

Block Size
2 to 2048 points (to 8192 points optional).

Resolution
3 digits.

Accuracy
±2% for non-ARB modes.
±0.2% for ARB modes.

Repeatability (24 hr)
±1% for non-ARB modes, 0.01% for ARB modes.

Jitter
≤0.1% ±100 ps.

Control
Frequency may be controlled by programmed value or external VCG input.
Value: Frequency value is keyboard or GPIB programmable with automatic range selection.
VCG (Voltage Controlled Generator): AC or dc input controls frequency. +0.01 to +12V into 10 kΩ for up to 1200:1 frequency change in each of 9 frequency ranges (ranges must be programmed). Slew rate is limited to 1V/μs.

AMPLITUDE

Range
0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ) from main output. Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).

Resolution
3 digits or 10 mV when absolute peak amplitude plus offset >0.5V; 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V.

Accuracy
±2% of programmed value and:
±5 mV for 0.1 to 1V (peak amplitude + offset <0.5V),
±20 mV for 1.01 to 10V,
±50 mV for all other.

Repeatability (24 hr)
±1% ±10 mV.

Flatness (At 5 Vp-p)
0.1 dB to 100 kHz, 1.5 dB to 12 MHz.

MODEL 275 PROGRAMMABLE FUNCTION GENERATORS

OFFSET

Range
DC or offset programmable from −5V to +5V into 50Ω (−10V to +10V into ⩾50 kΩ). Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ⩾50 kΩ).

Resolution
3 digits or 10 mV when absolute peak amplitude plus offset >0.5V, 3 digits or 1 mV when absolute peak amplitude plus offset ⩽0.5V.

Accuracy
±40 mV in dc function.

Repeatability (24 hr)
±20 mV.

OUTPUTS

Function Output
Source of primary waveforms.
Program Control Provides:
Output On, (50Ω source impedance);
Output Off, High Z (>500 kΩ);
Output Off, Low Z (approx 50Ω termination).
Protection: Output protected to 140 Vac or 200 Vdc without internal damage.

Sync Output
Sync signal is at programmed frequency and TTL level.
Level: ⩽0.4V to ⩾2.4V into 50Ω, ⩽0.8V to ⩾4.8V into ⩾50 kΩ.
Source Impedance: 50Ω.
Timing: Concurrent with function output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Protection: Output protected from short circuit to any voltage between ±15 Vdc input minimum.

ARB Sync Output
0 to +5V into 600Ω, programmable phase control. RCL 4000 initiates positive ARB sync; RCL 4001 initiates negative ARB sync.
Source Impedance: 600Ω.
Protection: Output protected from short circuit to voltage between ±15V.

INPUTS

External Trigger
Trigger of input circuit is programmable for a + or − signal slope and required threshold level.
Level: −10 to +10V.
Resolution: 20 mV.
Accuracy: ±500 mV.
Input Impedance: 10 kΩ.
Maximum Trigger Rate: 12 MHz (15 MHz for External Width).
Minimum Trigger Width: 20 ns.
Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 15 MHz.
Protection: Input protected to ±50V.

VCG In
Voltage control of generator frequency. See frequency.
Range: 0.01 to 12V.
Impedance: 10 kΩ.
Protection: Input protected to ±50V.

ARB RTS/Hold Input
Trig input and RTS/Hold input are internally common. Having two inputs provides processing for independently generated trigger and RTS/Hold signals.
Protection: Input protected from short circuit to any voltage between ±15V.

INTERNAL TRIGGER

Non-ARB Functions
Range: 3.75 mHz to 3.75 MHz.
Resolution: 4 digits.
Accuracy: 0.2%.

ARB Functions
Range: 10 mHz to 3.75 MHz.
Resolution: 3 digits.
Accuracy: 2%.

ARB CHARACTERISTICS

Horizontal Resolution
2048 points standard; 8192 optional.

Vertical Resolution
12 bits (−2048 to +2047).

Auto-line
Draws straight line between two data points.

Programmable Filter (ARB Waveforms)
Non-filtered ARB Waveform: Settling time <1.5μs.
Filtered ARB Waveform: Settling time approximately 0.6 ms.

Programmable Ramp-to-Start Rate
Fast: Approximately 5 ms/bit;
Slow: Approximately 20 ms/bit.

Programmable 3 Digit ARB Clock
Period Ranges from 267s to 267 ns with 0.2% accuracy.

GPIB PROGRAMMING

IEEE 488-1978 compatible. Non-isolated. Double buffered.

Address
0−30, keyboard or internal switch selectable. Internal switch can lock out keyboard selection. Power-up address is internal setting.

Subsets
SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.

Interface Timing

Frequency	16 ms
Amplitude	13 ms
Offset	14 ms
Mode	6 ms
Function	5 ms
Int/Ext	5 ms
Execute	20 ms to 4 sec

Interface Timing (Cont.)

Store	11 ms
Output	10 ms
Slope	5 ms
Burst Count	10 ms
Rate	35 ms
Recall	185 ms
Reset	185 ms
Start	20 ms
Stop	20 ms
GET Mode	5 ms to 4 sec
Adrs	10 ms
Data	15 ms
Auto-line	20 ms to 2 sec

GENERAL

Stored Settings
Nonvolatile memory stores 75 settings.

Environment
Temperature Range: 20°C ± 10°C for specified operation, operates 0°C to 50°C, −50°C to +75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft for operation. To 40,000 ft for storage.
Relative Humidity: 95% at 20°C and at sea level (non-condensing).

Dimensions
21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.

Weight
5.9 kg (13 lb) net; 7.2 kg (16 lb) shipping.

Power
90 to 105, 108 to 126, 198 to 231, or 216 to 252 Vrms; 48 to 66 Hz; 1 phase; <40 watts.

OPTIONS

002: Rear Panel Connectors
BNCs relocated to rear panel.

004: Extended Block Size
Extends block size to 8192 points.

ACCESSORIES

Style 12: Single Rack Adapter Kit
Allows any 270 series instrument to be right or left mounted in a standard 19 inch rack. 5¼ inches high.

Style 13: Dual Rack Adapter Kit
Allows any two 270 series instruments to be mounted side-by-side in a standard 19 inch rack. 5¼ inches high.

FACTORY/FOB

San Diego, CA

PRICE

Model 275	**$3750**
Option 002	**$125**
Option 004	**$400**
Style 12	**$75**
Style 13	**$125**

Arbitrary Waveform Generator

- **Advanced Easy-to-Use Waveform Entry & Editing**
- **Standard & User Defined Waveforms**
- **Up to 8K Horizontal Points**
- **Crystal Controlled Frequency Accuracy**

Model 75 is the solution for bench-top or manually-operated arbitrary waveform generator applications. "User friendly" advanced waveform editing capabilities make it the easiest arbitrary (ARB) generator to use.

Waveforms have a vertical resolution of 4095 points and a horizontal resolution adjustable from 2 to 8192 points. Waveform memory is broken up into four blocks of 2048 points. One waveform of up to 8192 points or four different waveforms (one active and three stored) of up to 2048 points each can be in memory at any one time.

The sample period is crystal controlled and adjustable from 500 nanoseconds to 50 seconds, allowing a waveform period of from 1 microsecond to 113.8 hours. The sample period can also be controlled by an external clock source having a period of 500 nanoseconds or larger.

Waveforms can be stopped and started at any point in the waveform either with an external signal, front panel pushbutton, or preprogrammed breakpoints.

Battery Backed Memory

Instrument state is stored in a battery backed memory, so that when the instrument is turned on it will contain the same setup and waveforms that it had when it was turned off.

Rubber Band Editing

Rubber band editing allows easy editing of waveforms or portions of the waveforms. The principle of this editing method is similar to stretching a rubber band between two "thumbtacks". A "thumbtack" is placed at each end of a waveform portion to be edited and the cursor is placed between them. (Cursor and thumbtacks are intensified for easy oscilloscope viewing.) The cursor can then be moved either horizontally or vertically, and the waveform will automatically follow in real time.

Additional Editing Features

The standard waveforms are inserted between the thumbtacks and can be edited using the editing features.

The amplitude and offset of a portion of the waveform can be changed by placing the thumbtacks at each end of the portion to be changed and using the digital amplitude and digital offset features.

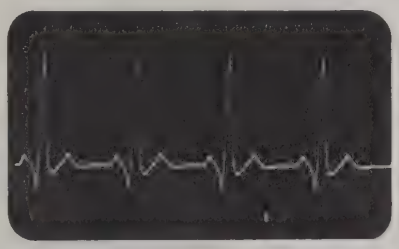
Communications Option

An optional RS-232-C or GPIB port is available for entering the waveform data and for external instrument control.

RS-232-C or GPIB numeric input is entered in free format (fixed, floating, or exponential notation). The parameters may be entered in any order and interactive error checks occur after the execute command.

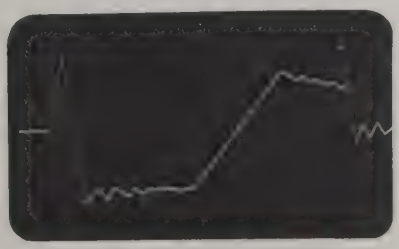
ARB Applications

Medical production and R&D applications for the 75 include testing of pacemakers and other medical equipment and simulation of heartbeats, nerve responses and EEG brainwave patterns. The high resolution of the 75 along with the ability to vary the time between waveforms make it particularly useful in these applications.



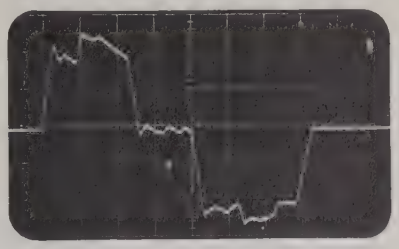
Heartbeat Simulation

Material testing is a traditional application for ARB generators. Hold, return-to-start, waveform counter, and breakpoints are features that make the 75 extremely useful for this application.



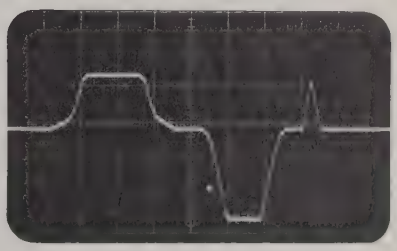
Typical Material Testing Waveform

Simulation of switcher motors, solenoids, and relays require special waveforms which simulate contact bounce. The Model 75 has been used to generate these special types of waveforms.



Contact Bounce Simulation

Disk drive manufacturers are using a modulated magnetic pickup technique to locate certain sync points on a spinning platter. Initial testing of these pickup amplifiers was hazardous, since an actual disk spinning at full speed was required for this precision work. The Model 75 simulates the spinning disk by providing the necessary sync waveforms to the pickup amplifiers. Flexibility of the ARB permits precise timing of waveforms through external triggering, as well as full level control and waveform switching.



Typical Disk Sync Waveform

Series Operation

Two or more Model 75's can be connected in series to produce waveforms that are longer than the 8192-point single unit maximum or to produce a sequence of different waveforms such as a burst of "normal" waveforms followed by an "abnormal" waveform.

Parallel Operation

Two or more Model 75's can be connected in parallel to produce multiple waveforms with adjustable phase relationships between them This can be used in applications such as multi-phase power testing and multi-axis stress and vibration testing.

WAVEFORMS (FUNCTIONS)

DC, square, triangle, up-ramp, down-ramp, sine, cosine, inverse sine, and haversine waveforms are provided. Each of these waveforms can be stored into the waveform memory between thumbtacks automatically, and then edited with the waveform editing functions if desired.

OPERATIONAL MODES

Continuous
Output runs repetitively from the programmed start address to the programmed stop address.

Triggered
Output quiescent until triggered by external signal or front panel pushbutton, then runs until another break point is encountered. Break points can be inserted anywhere in the waveform with the default break point at the beginning of the waveform.

Gated
Same as triggered mode except that the output is continuous for the duration of the gate signal and until the first break point encountered after the gate signal ends.

Burst
Same as in the triggered mode except that a programmable number of waveforms is counted before the waveforms stop. The maximum burst is 1,048,575 waveforms.

Toggled
The output is quiescent until triggered. It then runs continuously until another trigger stops the waveform at the next break point.

WAVEFORM RESOLUTION

Normal Waveform
2048 points horizontal × 4095 points vertical.

Chained Waveform
8192 points horizontal × 4095 points vertical. Stored waveforms are not available with chained operation.

SAMPLE RATE

Range
0.02 Hz to 2.0 MHz (50 s to 500 ns).

Waveform Period and Frequency
The actual waveform period is the number of horizontal points (from start to stop address) times the sample time. This can range from 1 microsecond for a square wave to 113.8 hours for a waveform using all 8192 points.

Frequency Resolution
4 digits.

Frequency Accuracy
±0.015%.

Repeatability (24 Hr)
±25 ppm.

Temperature Coefficient
≤5 ppm/°C.

OUTPUT SIGNALS

Amplitude
Range: ±0.005 to 5 Vp into 50Ω (0.01 to 10 Vp-p into 50Ω). ±0.01 to 10 Vp into an open circuit (0.02 to 20 Vp-p into an open circuit).
Resolution: 3 digits.
Accuracy: ±1.8% of setting and ±2.5 mV for amplitude + offset ≥0.5V.
±1.8% of setting and ±0.25 mV for 0.5V > amplitude + offset ≥50 mV.
±1.8% of setting and ±25 μV for 50 mV > amplitude + offset.
Repeatability (24 Hr): ±0.1% of setting.
Temperature Coefficient: ≤150 ppm/0°C of setting.

Offset
Range: +5V to −5V into 50Ω (−10V to +10V into an open circuit). Absolute amplitude plus offset may not exceed ±5V into 50Ω (±10V into an open circuit).
Resolution: 3 digits.
Accuracy: 2% of setting and ±15 mV for amplitude + offset ≥0.5V.
2% of setting and ±1.5 mV for 0.5V > amplitude + offset ≥50 mV.
2% of setting and ±0.15 mV for 50 mV > amplitude + offset.
Repeatability (24 Hr): ±5 mV and ±0.1% of setting.
Temperature Coefficient: ≤1 mV/°C and ≤150 ppm/°C of setting.

OUTPUTS

ARB Out (50Ω)
Source of primary waveform output. Maximum amplitude is ±5 Vp into 50Ω. Output is fuse protected.

Sync Out (TTL)
Will drive up to 10 LSTTL loads. This is a pulse 1 sample time wide that is usually used to sync an oscilloscope or another ARB generator. Pulse position is adjustable to any point in the waveform.

Burst Done Out (TTL)
Will drive up to 10 LSTTL loads. A TTL low indicates that the waveform is running. TTL high indicates that the instrument is waiting for a trigger in triggered, gated, toggle, or burst modes. Used primarily to start another ARB generator in series operation.

Ref Out (TTL)
Will drive up to 10 LSTTL loads. This pulse train at the sample frequency is used primarily as a reference source for other ARB generators in series operation or in parallel operation.

Z-Axis Out
This signal is a pulse, adjustable in amplitude from 2 to 14 volts, that is used to modulate the Z-axis of an oscilloscope when using the waveform editing features. The logic polarity is also selectable.

INPUTS

Sum In (50Ω)
The signal at this input is added to the arbitrary waveform to produce an output (at waveform out) of the sum of the two. A peak input of ±5V will produce an output equal to the amplitude setting. Input is fuse protected. Accuracy is 4% (2% if fuse is shorted).

Trig In (TTL)
Impedance is 100 KΩ. Signal is used to control the generator in the trigger, gate, toggle, and burst modes. Slope polarity is selectable.

Sync In (TTL)
Impedance is 100 KΩ. A high input causes the waveform to restart at the start address. Primarily used for synchronizing several arbitrary waveform generators in parallel operation.

Ref In (TTL)
Impedance is 100 KΩ. This signal input is used for the sample clock when the external ref is selected.

Hold In
Impedance is 100 KΩ. A TTL low or switch closure at this input causes the generator to stop at the current output level and remain there until released by a TTL high or switch opening.

Return In
Impedance is 100 KΩ. A TTL low or switch closure at this input causes the output level to ramp back to the start value. The ramp rate is front panel selectable from 0 to 100 ms per point.

TRIGGER SOURCES

Manual
Use the Trigger pushbutton switch on front panel to operate internal trigger circuitry. The slope polarity can be set via the display menus.

External
Use the communication ports (GPIB or RS-232-C) or the Trig In connector on front panel. Trig In connector frequency input can be up to 1 MHz. The slope polarity can be set via the display menus.

WAVEFORM CHARACTICS

Horizontal Resolution
Up to 8192 points.

Vertical Resolution
4095 bits (−2047 to +2047).

Rise/Fall Time
<350 ns.

COMMUNICATION PORTS (OPTIONAL)

IEEE-488 Port (Option 001)

Type: IEEE-488-1978 compatible, non-isolated, double buffered.
Address: 0-30, internal DIP switch selectable or front panel selectable.
Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E1.

RS-232-C Serial Port (Option 002)

Communication: Full duplex (bi-directional) with CTS/DTR or XON/XOFF handshaking.
Connector: Rear panel mounted DB-25 (female) with DCE or DTE configuration.
Data Format: 8 bits, no parity, one stop bit.
Data Rate: 14 steps internal switch selectable (50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, 19,200).

GENERAL

Environmental

Temperature Range: +23°C ±5°C for specified operation, operates 0 to +50°C, −20 to +75°C for storage.
Warmup Time: 20 minutes for specified (guaranteed for 1 year) operation.
Vibration: 5 to 55 Hz with maximum of 2g at 55 Hz.
Shock: 30g, 11 ms half sine.
Altitude: Sea level to 10,000 ft. for operation. Sea level to 40,000 ft. for storage.
Relative Humidity: 95% at 25°C and at sea level (non-condensing).
Dimensions: 21 cm (8.27 in.) wide, 10 cm (3.94 in.) high, 32.3 cm (12.72 in.) deep.
Weight: 3.55 kg (7.8 lb) net, 4.68 kg (10.3 lb) shipping.
Power: 90 to 128, 180 to 256 rms; 48 to 66 Hz; single phase; <25 VA.

OPTIONS

001: IEEE-488 (GPIB) Port
For instrument control or entering waveform data.

002: RS-232-C Serial Port
For instrument control or entering waveform data.

NOTE: Options 001 and 002 are mutually exclusive.

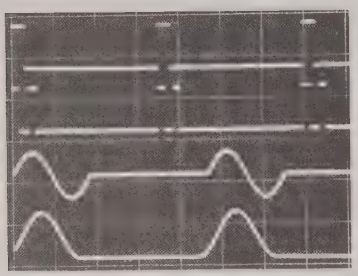
FACTORY/FOB

San Diego, CA

PRICE

Model 75	**$1995**
Option 001	**$395**
Option 002	**$395**

20 MHz Pulse/Function Generators



- **Frequency From 0.0001 Hz to 20 MHz**
- **Full 30 Volt Peak-to-Peak Output**
- **Continuous, Triggered and Gated Operation**
- **Fixed TTL and ECL Outputs (145)**
- **Delayed and Double Pulse Outputs (145)**

Models 143 and 145
Both 20 MHz function generators are precision sources of sine, square and triangle waveforms, and positive and negative pulses. The frequency range is variable from 0.0001 Hz (2.78 hour period) to 20 MHz, and the frequency can be modulated, swept or dc controlled over a 1000:1 range by an external voltage. Output can be continuous or the generator can be triggered or gated by an external control signal or front panel switch.

30 Volts Peak-to-Peak
A calibrated 20 dB per step attenuator and 20 dB vernier give 80 dB control for a 1.5 mV p-p to 30 Vp-p output signal.

Variable DC and Start/Stop Point
Other key features of both models are DC offset, triggered waveform start/stop point control and an X-Y recorder frequency axis drive.

Model 145
In addition to the features described above, Model 145 provides pulse outputs with calibrated repetition rates up to 20 MHz. Convenient fixed amplitude outputs are available for TTL and ECL. The variable pulse output gives pulses up to a full 30V peak-to-peak. For further utility you can select delayed or double pulses and continuous, triggered or gated output. Pulse width and delay are independently controllable.

MODELS 143 & 145 FUNCTION GENERATORS

VERSATILITY

Waveforms
Selectable sine ∿, square ⊓, triangle △, positive square ⎍, negative square ⎌, TTL sync pulse and dc.
(143 only.) Symmetry of waveforms may be varied for sawtooth and variable duty cycle pulses.
(145 only.) Fixed amplitude pulses of TTL, $\overline{\text{TTL}}$, ECL and $\overline{\text{ECL}}$, all simultaneously available with function output.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.
Triggered: Generator is quiescent until triggered by an external signal or manual trigger, then generates one cycle at selected frequency.
Gated: As triggered mode, except generator oscillates for the duration of the gate signal. Last cycle started is completed.

Frequency Range
0.0001 Hz to 20 MHz in 10 overlapping ranges with approximately 1% vernier control.

Function Output
∿, ⊓, △ selectable and variable to 30 Vp-p (15 Vp-p into 50Ω). ⎍, ⎌, to 15 Vp (7.5 Vp into 50Ω). All waveforms and dc can supply 150 mA peak current and may be attenuated to 60 dB in 20 dB steps with an additional 20 dB vernier.

DC Output and DC Offset
Selectable through FUNCTION OUT output. Controlled by front panel control or by applying an external voltage. Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 into 50Ω). External offset sensitivity approximately −1 V/V with output into open circuit. DC offset and output waveform attenuated proportionately by the 60 dB output attenuator.

Sync Output
A TTL level pulse. Will drive 50Ω termination.

GCV—Generator Controlled Voltage
At GCV OUT connector, a 0 to +2V signal proportional to generator frequency. 600Ω source impedance.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to 2 volt signal to VCG IN connector. Upper and lower frequencies limited to maximum and minimum of selected range.
Slew Rate: 2% of range per μs.
Linearity:
±0.2% for 10 Hz to 200 kHz;
±0.75% for 0.001 Hz to 2 MHz.
Impedance: 2 kΩ.

Trigger and Gate
Input Range: 1 Vp-p to ±10V.
Impedance: 10 kΩ, 33 pF.
Pulse Width: 25 ns min.
Repetition Rate: 10 MHz max.
Adjustable Triggered Signal Start/Stop Point: Approximately −90° to +90° to 2 MHz.

Symmetry
(143 only.) Symmetry of all waveform outputs is continuously adjustable from 1:19 to 19:1 for variable duty-cycle pulses, sawtooth ramps and distorted sine waves.
NOTE: When SYMMETRY control is used, indicated frequency is divided by approximately 10.

FREQUENCY PRECISION

Dial Accuracy
From ×.01 Hz to ×1 MHz: ±3% of full range.
×10 MHz: ±5% of full range.

Time Symmetry
Square wave variation:
0.001 Hz to 200 kHz: <±1%.
20 Hz to 20 kHz: <±0.5%.

AMPLITUDE PRECISION

Amplitude Change With Frequency
Sine variation:
0.001 Hz to 200 kHz: <±0.1 dB.
200 kHz to 2 MHz: <±0.5 dB.
2 to 20 MHz: <±3.0 dB.

Step Attenuator Accuracy
±0.3 dB per 20 dB step at 2 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion
×100 Hz to ×10 kHz: <0.5%.
×.01 to ×10 Hz and ×100 kHz: <1.0%.
×1 MHz: All harmonics 34 dB below fundamental.
×10 MHz: All harmonics 26 dB below fundamental.

Square Wave Rise/Fall Time
At FUNCTION OUT <20 ns for 15 Vp-p output into 50 Ω load.

PULSE GENERATOR

(145 only.)

Pulse Outputs
Variable amplitude pulse, and simultaneous fixed ECL, $\overline{\text{ECL}}$, TTL and $\overline{\text{TTL}}$ pulses and TTL sync pulse. All outputs can drive 50Ω terminations.

Operational Modes
Continuous, triggered and gated plus the following.
Normal Pulse: Adjustable width pulse in phase with sync signal.
Delayed Pulse: Pulse delayed with respect to normal pulse. Pulse delay and pulse width adjustable.
Double Pulse: Two pulses for every period. Time between pulses and pulse width adjustable. Minimum period 100 ns.

Pulse Period Range
50 ns to 10,000s in 10 overlapping ranges with approximately 1% vernier control.

Pulse Width
25 ns to 1 ms in 5 overlapping ranges with vernier control. Includes OFF and square wave.

Pulse Delay
50 ns to 10 ms in 6 overlapping ranges with vernier control.

Duty Cycle
Duty cycles to 70% for periods >100 ns (<10 MHz); for periods <100 ns (>10 MHz) duty cycles are approximately 50%.

Function Output
Variable to 30 Vp-p into 50Ω). DC offset and attenuation are same as for function generator.

Pulse Rise/Fall Times
At FUNCTION OUT, <20 ns for 15 Vp-p output into 50Ω load.

GENERAL

Stability
Short Term: ±0.05% for 10 min.
Long Term: ±0.25% for 24 hours.
Percentages apply to amplitude, frequency and dc offset.

Environment
Specifications apply at 23° ±5°C. Instrument will operate from 0° to +50°C ambient temperatures.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 27.3 cm (10¼ in.) deep.

Weight
Model 143: 4.2 kg (9.3 lb) net; 5.5 kg (12 lb) shipping.
Model 145: 4.5 kg (10 lb) net; 5.9 kg (13 lb) shipping.

Power
90 to 105V, 108 to 126V, 198 to 231V and 216 to 252V selectable; 48 to 400 Hz; less than 30 VA.

NOTE: All specifications apply from 0.1 to 2.0 on frequency dial, when FUNCTION OUT is at maximum and 50Ω terminated, and (143 only) with SYMMETRY control at OFF. Symmetry and vernier affect frequency calibration. Maximum possible asymmetry is a function of frequency setting. Model 145 function generator specifications apply when PULSE WIDTH control is OFF.

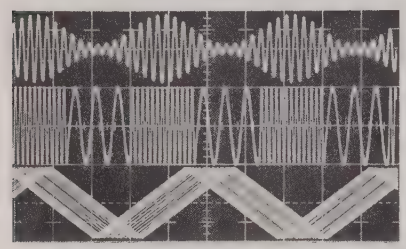
FACTORY/FOB

San Diego, CA

PRICE

Model 143	**$1395**
Model 145	**$1750**

20 MHz AM/FM/PM Generator



- **Two Complete Generators**
- **Internal or External AM, FM and Phase Modulation**
- **0.0002 Hz to 20 MHz, 30V Output**
- **Sweep, Trigger and Gate**
- **30 Volt Peak-to-Peak Output**

Two Complete Generators
Wavetek's Model 148A AM/FM/PM Generator gives you a one instrument source of modulated waveforms. It has two generators: a main function generator, with full function generator versatility, and a modulation generator, a convenient source for modulating and triggering waveforms or a second, independent signal source.

Internal or External Modulation
Modulation may be internal or external in any combination. Amplitude may be modulated from zero through 100% and in a suppressed carrier mode; frequency may be modulated or swept to three decades; and phase may be modulated a full plus or minus 50 degrees.

Function Generator
The main generator generates from 200 μHz to 20 MHz in continuous, triggered and gated modes with a 30V peak-to-peak maximum amplitude. A unique overload LED indicates output clipping due to excessive amplitude plus offset. Variable symmetry and trigger stop/start controls provide additional special waveforms, and a four step attenuator with vernier provides 80 dB of amplitude control. A variable trigger level control accepts main generator triggering signals from the modulation generator or trigger signals from an external source.

Generates Complex Waveforms
Main generator frequency, amplitude and triggering source are independently or simultaneously controlled by the modulation generator or external signal. The model 148A can generate an unlimited variety of complex waveforms.

VERSATILITY

Instrument consists of a main generator and a modulation generator which can be connected internally for amplitude, frequency or phase modulated signals or for self-triggering and tone burst signals.

MAIN GENERATOR

Waveforms
Sine ∿ , triangle △ , square ⊓ , positive square ⎍ , negative square ⎎ , TTL pulse and dc.

Operational Modes
Continuous, external trigger and gate, and internal trigger and gate.

Modulation Modes
AM: Internal - waveform amplitude is modulated from 0 to >100%.
AM: External - AC signal gives suppressed carrier operation.
FM: Internal modulation or external ac or dc signal provides voltage control of frequency. Up to 1000:1 frequency change possible; linear within limits of selected range.
Sweep: Ramp signal sweeps the main output signal frequency from low to high or vice versa. frequency sweeps to 1000:1 within the selected range. Internal ramp can be held at limits for precision upper and lower frequency setting.
PM: Internal or external modulation signal causes instantaneous carrier frequency shift proportional to rate of signal amplitude change, producing up to ±50° carrier phase shift. Enabled for main generator frequency range ×100 and above.

Frequency Range
0.0002 Hz to 20 MHz in 10 overlapping ranges with vernier.

Function Output (50Ω)
∿ , △ , ⊓ selectable and variable to 30 Vp-p (15 Vp-p into 50Ω). ⎍ , ⎎ up to 15 Vp (7.5 Vp into 50Ω). All waveforms and dc give 150 mA peak current and attenuate to 60 dB in 20 dB steps plus 20 dB continuous control.

DC Output and DC Offset
Between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 Vdc into 50Ω).

Sync Output (TTL)
TTL level pulse which will drive 10 TTL loads.

External Modulation Input
AM: Sensitivity of 3 Vp out/Vp (1.5V into 50Ω). Input impedance is >2.5 kΩ.
FM: Sensitivity of 20% of frequency range/Vp. Input impedance is 5 kΩ.
PM: Sensitivity of 10° phase shift/Vp. Input impedance is 10 kΩ.

Symmetry
Symmetry of all waveform outputs is continuously adjustable from 1:19 to 19:1. Varying symmetry provides variable duty-cycle pulses, sawtooth ramps and nonsymmetrical sine wave.
NOTE: When SYMMETRY control is used indicated frequency is divided by approximately 10.

Trigger and Gate
Input Range: 1V p-p to ±10V.
Impedance: 10 kΩ, 33 pF.
Pulse Width: 25 ns min.
Repetition Rate: 10 MHz max.
Adjustable Triggered Signal Start/Stop Point: Approximately −90° to +90° to 2 MHz.

FREQUENCY PRECISION

Dial Accuracy
±(1% of setting +1% of full range) on ×100 thru ×1M ranges.
±(2% of setting +2% of full range) on ×.01 thru ×10 and ×10M ranges.

Time Symmetry
±0.5% on ×100 thru ×100K ranges and from 0.2 to 2.0 on dial.
±5% on all other ranges and from 0.02 to 2.0 on dial.

AMPLITUDE PRECISION

Amplitude Change With Frequency
Sine variation less than:
±0.1 dB through ×100K ranges;
±0.5 dB on ×1M range;
±3 dB on ×10M range.

Step Attenuator Accuracy
±0.3 dB per 20 dB step at 2 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion
<0.5% on ×100 to ×10K ranges.
<1.0% on ×0.01 to ×10 and ×100K ranges.
All harmonics 30 dB below fundamental ×1M range.
All harmonics 26 dB below fundamental on ×10M range.

Square Wave Rise/Fall Time
At FUNCTION OUT <25 ns for 15 Vp-p into 50Ω load.

MODULATION GENERATOR

Modulation Generator

Waveforms
Selectable ∿ , △ , ⊓ , ⩘ and ⩙

Frequency Range
∿ , △ , ⊓ : 0.1 Hz to 100 kHz in three 100:1 ranges.
⩘, ⩙ Sweep: 0.2 Hz to 200 kHz (2× setting).

Output (600Ω)
∿ , △ and ⊓ are fixed level 10 Vp-p. ⩘ and ⩙ are fixed level 0 to +5V (open circuit).

Frequency Modulation (FM IN)
Voltage control of modulator frequency with sensitivity of 20% of range/volt. Input impedance is 5 kΩ.

WAVEFORM CHARACTERISTICS

Sine Distortion
<5%.

Time Symmetry
<1% from 1 Hz to 10 kHz.
<5% from 0.1 Hz to 100 kHz.

GENERAL

Stability
Short Term: ±0.05% for 10 min.
Long Term: ±0.25% for 24 hr.
Precentages apply to amplitude, frequency and dc offset.

Environment
Specifications apply at 23° ±5°C. Instrument will operate from 0° to +50°C ambient temperatures.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 27.3 cm (10¾ in.) deep.

Weight
4.5 kg (10 lb) net; 5.9 kg (13 lb) shipping.

Power
90 to 105V, 108 to 126V, 198 to 231V and 216 to 252V selectable; 48 to 400 Hz; less than 40 VA.

NOTE: Unless otherwise noted, all specifications apply from 0.1 to 2.0 on frequency dial, when FUNCTION OUT is at maximum and 50Ω terminated, with SYMMETRY control at OFF. Symmetry and vernier affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

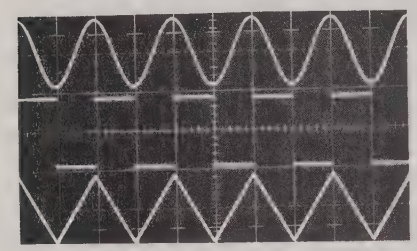
FACTORY/FOB

San Diego, CA

PRICE

Model 148A	**$1695**

20 MHz Function Generator



- 0.002 Hz to 20 MHz Frequency Range
- Triggered and Gated Modes
- 30 Volt Peak-to-Peak Output
- DC Offset with Calibrated Zero
- Symmetry Control

Frequency Range

Model 190 covers a wide 2 mHz (500 second periods) to 20 MHz frequency span in nine overlapping ranges. Each multiplier setting gives you a full 1000:1 frequency band with calibrated dial and voltage control of frequency throughout.

Triggered and Gated Waveforms

Three generator modes give the Model 190 operating versatility. In continuous mode, the waveform is generated repetitively at the selected frequency. Or, you can select triggered mode and the generator remains quiescent at a dc baseline until your external signal or manual trigger initiates a single waveform cycle. The third mode, gated is similar to triggered except the generator produces a burst of waveform cycles for the duration of the manual or external signal.

High Power Output

The high level output is a full 30 volts peak-to-peak from a 50Ω source (15 Vp-p into 50Ω) with a maximum peak current of 150 milliamperes. This high power output allows you to drive low impedance and capacitive loads without saturating or degenerating the waveform output. Output can also be exactly attenuated down to 80 dB for your precise signal requirement.

Voltage Controlled Generator Frequency

You can externally modulate or sweep the generator frequency in each of its 1000:1 ranges with dc or ac signals. For example, you can sweep the entire 20 Hz to 20 kHz audio band without switching ranges.

DC Offset With Calibrated Zero

Convenient front panel dc offset control lets you raise or lower the output waveform with respect to signal ground. You don't have to use an oscilloscope every time you want a balanced waveform; the 190 gives you a calibrated zero dc offset position.

Variable Symmetry

In addition to the sine, square and triangle waveforms, variable symmetry gives sawtooth ramps, pulses and nonsymmetrical sine waves with symmetry ratios up to 19:1. You can use these waveforms when you need pulses with variable duty cycle or ramps with variable rise/fall ratios.

MODEL 190 FUNCTION GENERATORS

VERSATILITY

Waveforms
Selectable sine ∿, triangle △, square ⊓, and dc with TTL sync.

Symmetry
With SYM on, waveforms may be varied to produce sawtooth ◿ and variable duty cycle pulse ⊓ from 1:19 to 19:1.

When SYMMETRY control is used, indicated frequency is divided by approximately 10.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.
Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one cycle at selected frequency.
Gated: As triggered mode, except generator oscillates for the duration of gate signal plus time to complete the last cycle.

Frequency Range
0.002 Hz to 20 MHz in 9 overlapping decade ranges with approximately 1% of full scale vernier control.

Function Output
∿, ⊓, △ selectable and variable to 30 Vp-p (15 Vp-p into 50Ω). All waveforms and dc can supply 150 mA peak current and may be attenuated in 10 db steps to 70 dB with 10 dB vernier for overall attenuation of 80 dB. 50Ω source impedance.

DC Output and DC Offset
Selectable through function output BNC. Controlled by front panel control with separate on-off switch. Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 Vdc into 50Ω). DC offset and output waveform attenuated proportionately by the 0 to 70 dB output attenuator.

Sync Output
A TTL level pulse when terminated with 50Ω. Duty cycle varies with symmetry. 50Ω source impedance.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ±5V signal. Upper frequency is limited to maximum of selected range.
Slew Rate: 2% of range per μs.
Linearity: ±0.5% through ×100K range. ±5% on ×1M and ×10M ranges.
Impedance: 10 kΩ.

Trigger (and Gate) Input
Input Range: 1 Vp-p to ±10V.
Trigger Level Adj: −5V to +5V.
Impedance: 1.5 kΩ shunted by 1.5 pF.
Pulse Width: 25 ns min.
Repetition Rate:

Input	Max Rep Rate
±1V	1 MHz
±2.5V	10 MHz

FREQUENCY PRECISION

Dial Accuracy
×0.1 Hz to ×1 MHz Range: ±3% of full scale.
×10M Range: ±5% of full scale.

AMPLITUDE PRECISION

Amplitude Change with Frequency
Sine variation with frequency:
All Ranges Through ×100K: <±0.2 dB.
×1M Range: <±0.5 dB.
×10M Range: <±1.5 dB.

Step Attenuator Accuracy
10, 20 and 40 dB Attenuator Setting: ±0.3 dB.
30, 50 and 60 dB Attenuator Setting: ±0.6 dB.
70 dB Attenuator Setting: ±0.9 dB.

WAVEFORM CHARACTERISTICS

Sine Distortion
×1K and ×10K Ranges: <0.5%.
×0.1 to ×100, and ×100K Ranges: <1.0%.
×1M Range: All harmonics 30 dB below fundamental.
×10M Range: 25 dB below fundamental.

Square Wave
Rise/Fall Time:
<15 ns (10% to 90%).
Total Aberrations:
5% of full amplitude (each peak of waveform).

Time Symmetry
Square Wave Variation From 0.1 to 2 on Dial:
<±1% to 200 kHz.
<±10% to 20 MHz.

Triangle Linearity
0.002 Hz to 200 kHz: <99%.

GENERAL

Stability
Amplitude, frequency and dc offset after 2 hour warm up.
Short Term: ±0.05% for 10 minutes.
Long Term: ±0.25% for 24 hours.

Environment
Specifications apply at 23° ±5°C. Instrument operates from 0° to +50°C.

Dimensions
28.6 cm (11¼ in.) wide; 8.9 cm (3½ in.) high; 28.6 cm (11¼ in.) deep.

Weight
3.5 kg (7.7 lb) net; 4.5 kg (10 lb) shipping.

Power
100/120/220/240V (+5%, −10%), 48 Hz to 66 Hz, 70 VA.

NOTE All specifications apply from 0.1 to 2.0 on frequency dial, when FUNC OUT is maximum and 50Ω terminated, and with SYM control OFF.

SYMMETRY and VERNIER controls affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

When SYMMETRY control is used, indicated frequency is divided by approximately 10.

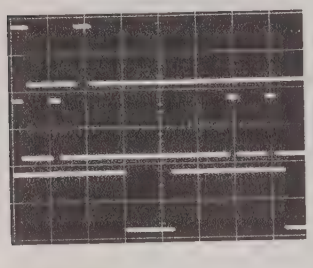
FACTORY/FOB

San Diego, CA

PRICE

Model 190	**$1195**

20 MHz Pulse/Function Generator



- 0.002 Hz to 20 MHz Frequency Range
- Versatile Pulse and Burst Modes
- Full Function Generator Performance
- Triggered and Gated Bursts with Rate and Width Control
- Full 30 Volts Peak-to-Peak Output

Burst and Pulse Control
In one instrument, Model 191 gives you a function generator with complete burst control—and a pulse generator. A 0.002 to 20 MHz frequency range main generator with a built-in combination burst/pulse generator gives you more than the usual pulse/function generator.

Burst Versatility
A burst of any number of waveforms can now be thought of as a waveform itself. The burst can be triggered, it can be gated, or it can run at a 1 Hz to 5 MHz rate continuously. Remember, internally, the burst itself can be any waveform running at any rate.

Pulse Format
A wide range of pulse formats allow many pulse timing and amplitude designs for your testing needs. For example, delays of either the pulse or its sync signal of up to 100 milliseconds; double pulse separation to 100 milliseconds; fixed baselines at pulse upper level, midpoint or lower level for amplitude control to 30 Vp-p; Widths 20 ns to 100 ms and continuous, triggered and gated modes.

These capabilities make the 191 an extremely versatile instrument for engineering, manufacturing and laboratory applications.

MODEL 191 FUNCTION GENERATORS

MAIN GENERATOR

Waveforms
Selectable sine ∿, triangle △, square ⊓, pulses ⎍, double pulses ⎍⎍ and dc.

Symmetry
With SYM on, waveforms may be varied to produce sawtooth ◿ and variable duty cycle pulse ⊓ from 1:19 to 19:1.

Operational Modes

Function

Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator is triggered by external signal or manual trigger, then generates one cycle.

Gated: As triggered mode, except generator oscillates for duration of gate signal plus time to complete the last cycle.

Burst
Internal burst generator gates main generator and operates in continuous, triggered and gated modes.

Burst Rate: 1 Hz to 5 MHz in 7 ranges.

Burst Width: 20 ns to 100 ms in 7 ranges.

Frequency Range
0.002 Hz to 20 MHz in 9 overlapping decade ranges with 1% vernier.

Function Output
∿, ⊓, △ and pulse selectable. Amplitude variable to 30 Vp-p (15 Vp-p into 50Ω). Pulse and ⊓ : baseline selectable (⎍, ⎍, ⎍), amplitude variable from baseline, and can be inverted. ⎍, ⎍ can be varied to 15 Vp-p (7.5 Vp-p into 50Ω). All waveforms and dc can supply 150 mA peak current and may be attenuated in 10 db steps to 70 dB with 10 dB vernier for overall attenuation of 80 dB. 50Ω source impedance.

DC Output and DC Offset
Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 Vdc into 50Ω). DC offset and output waveform attenuated proportionately by the 0 to 70 dB output attenuator.

Sync Output
A TTL level pulse when terminated with 50Ω. Duty cycle varies with symmetry control. 50Ω source impedance.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ±5V signal. Upper frequency is limited to maximum of selected range.

Slew Rate: 2% of range per μs.

Linearity: ±0.5% thru ×100K range. ±5% on ×1M and ×10M ranges.

Impedance: 10 kΩ.

Trigger (and Gate) Input

Input Range: 1 Vp-p to ±10V.

Trigger Level Adj: −5V to +5V.

Impedance: 1.5 kΩ shunted by 1.5 pF.

Pulse Width: 25 ns minimum

Repetition Rate:

Input	Max Rep Rate
±1V	1 MHz
±2.5V	10 MHz

PULSE GENERATOR

Pulse Modes

Normal Pulse: Adjustable width pulse in phase with pulse sync output.

Pulse Delay: Pulse delayed with respect to pulse sync output. Pulse delay and pulse width adjustable.

Double Pulse: Two pulses for every period. Time between pulses and pulse width adjustable.

Sync Delay: Pulse sync output delayed with respect to pulse output.

Function modes of Continuous, Triggered and Gated, but not Burst, also applicable.

Pulse Period Range
50 ns to 500s in 9 decade ranges.

Pulse Width
20 ns to 100 ms in 7 ranges.

Pulse or Sync Delay
0 ns to 100 ms in 7 ranges.

Duty Cycle
Up to: 75% for pulse widths >100 ns. 50% for pulse widths of 20 to 100 ns.

Pulse/Burst Sync Output
TTL level pulse when terminated with 50Ω. Reference for pulses and bursts at function output BNC and TTL pulse BNC.

In pulse function mode (normal pulse) and burst mode, sync output is coincident with leading edge of pulse/burst output and has width of at least 20% to 60% of minimum selected pulse/burst width except on the 20 to 100 ns range, which will have a sync pulse width of 10 ns to 30 ns.

Also see Pulse Modes.

FREQUENCY PRECISION

Dial Accuracy
±3% of full scale from ×0.1 Hz to ×1 MHz.
±5% of full scale on ×10M range.

AMPLITUDE PRECISION

Amplitude Change with Frequency
Sine variation with frequency:
<±0.2 dB on all ranges through ×100K.
<±0.5 dB on ×1M range.
<±1.0 dB on ×10M range.

Step Attenuator Accuracy
±0.3 dB with 10, 20 and 40 dB.
±0.6 dB with 30, 50 and 60 dB.
±0.9 dB with 70 dB setting.

WAVEFORM CHARACTERISTICS

Sine Distortion
<0.5% on ×1K and ×10K Ranges.
<1.0% on ×0.1 to ×100, and ×100K ranges.

All harmonics 30 dB below fundamental on ×1M range, and 25 dB below fundamental on ×10M range.

Square Wave and Pulse
Rise/Fall Time at Function output BNC:
<15 ns (10% to 90%).
Total Aberrations:
5% of full amplitude (each peak of waveform).

Time Symmetry
Square wave variation from 0.1 to 2 on dial:
<1% to 200 kHz.
<10% to 20 MHz.

Triangle Linearity
>99% for 0.002 Hz to 200 kHz.

GENERAL

Stability
Main generator amplitude, frequency and dc offset. After 2 hour warm-up:
±0.05% for 10 minutes.
±0.25% for 24 hours.

Environment
Specifications apply at 23° ±5°C. Instrument operates from 0° to +50°C.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 28.6 cm (11¼ in.) deep.

Weight
4.6 kg (10 lb) net; 5.9 kg (13 lb) shipping.

Power
100/120/220/240V (+5%, −10%), 48 Hz to 66 Hz, ⩽70 VA.

NOTE: All specifications apply from 0.1 to 2.0 on frequency dial, when FUNC OUT amplitude is maximum and 50Ω terminated, and with SYM control OFF.

When SYM control is used, indicated frequency is divided by approximately 10.

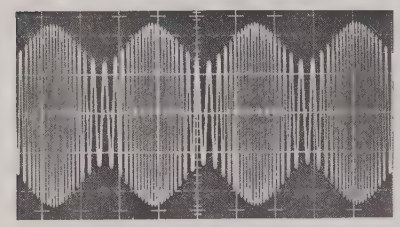
FACTORY/FOB

San Diego, CA

PRICE

Model 191	**$1495**

20 MHz Sweep/Modulation Generator



- **0.002 Hz to 20 MHz Frequency Range**
- **Independent Auxiliary Function Generator for AM, FM and Sweep Operation**
- **Static Setting of Modulation Parameters**
- **30 Volt Peak-to-Peak Output**

Sweep/Modulation
Model 193, a full 0.002 Hz to 20 MHz Generator, gives you sweep, frequency modulation and suppressed carrier modulation — all with precision waveforms from two independent function generators. The two generators each have sine, triangle and square waveforms with symmetry control. The main generator can be triggered and gated for single cycle or bursts of output.

Convenient Setups
Each modulation parameter has a static setup feature to allow its exact selection. Independently set these parameters: sweep start and width, AM carrier level and modulation level, suppressed carrier null, and FM center frequency deviation.

Auxiliary Generator
The auxiliary generator, in addition to being an internal modulation generator, can be independently used with its own ouput. This generator has its own waveforms, with symmetry control, and can be frequency modulated by an external signal. As an independent generator, it can be used to externally AM or FM the main generator in modes not available internally; for example, frequency shift keying.

30V Peak-to-Peak Output
The output amplifier provides up to 30V peak-to-peak amplitude from a 50Ω source. Zero to 80 dB attenuation lets you select signals down to 1.5 mV.

MODEL 193 FUNCTION GENERATORS

MAIN GENERATOR

Waveforms
Selectable sine ∿, triangle △, square ⊓, AM sine ⋈ and dc.

Symmetry
Symmetry control produces sawtooth ◿ and variable duty cycle pulse ⊓ from 1:19 to 19:1.*

Operational Modes
Continuous, triggered and gated.

Frequency Range
0.002 Hz to 20 MHz.

Function Output
Waveforms variable to 30 Vp-p (15 Vp-p into 50Ω). Waveforms may be attenuated continuously to 80 dB. 50Ω source impedance.

DC Output and DC Offset
Adjustable between ±15 Vdc (±7.5 Vdc into 50 Ω) with signal peak plus dc offset limited to ±15 Vdc (±7.5 Vdc into 50Ω). DC offset and waveform attenuated proportionately 10 dB/step to 70 dB.

Func Sync Output
TTL level pulse into 50Ω. Duty cycle varies with SYM control. 50Ω source impedance.

GCV Output
0 to +5V open circuit voltage level proportional to main generator frequency. 600Ω source impedance.

AM—Amplitude Modulation
External signal at AM IN (or external plus AUX GEN signal if AUX GEN AM selected) amplitude modulates main generator sine in selectable 0 to 100% AM or suppressed carrier modes.
AM Input: 5 Vp-p gives 100% modulation; 10 Vp-p gives suppressed carrier operation. 600Ω input impedance.
Carrier Level (0 to 100% AM): Adjustable 10 to 50% of full amplitude at function output.
Carrier Null (Suppressed Carrier AM): Adjustable ±2% of full amplitude at function output.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ±5V signal. Upper frequency limited to max. of range.
Slew Rate: 2% of range per μs.
Linearity: ±0.5% through ×100K range; ±5% on ×1M and ×10M.
Impedance: 10 kΩ.

Trigger Input
Input Range: 1 Vp-p to ±10V.
Trigger Level Adj: −5V to +5V.
Impedance: 1.5 kΩ shunted by 1.5 pF.
Pulse Width: 25 ns minimum.
Repetition Rate:

Input	Max Rep Rate
±1V	1 MHz
±2.5V	10 MHz

FREQUENCY PRECISION

Dial Accuracy
×0.1 Hz to ×1 MHz: ±3% of full scale.
×10M Range: ±5% of full scale.

AMPLITUDE PRECISION

Sine Frequency Response
All Ranges through ×100K: <±0.2 dB.
×1M Range: <±0.5 dB.
×10M Range: <±1.5 dB.

Step Attenuator Accuracy
10, 20 and 40 dB Setting: ±0.3 dB.
30, 50 and 60 dB Setting: ±0.6 dB.
70 dB Setting: ±0.9 dB.

WAVEFORM CHARACTERISTICS

Sine Distortion
×1K and ×10K Ranges: <0.5%.
×0.1 and ×100 Ranges: <1.0%.
×100K, ×1M Range: All harmonics 30 dB below fundamental.
×10M Range: 25 dB below fundamental.

Square Wave
Rise/Fall Time:
<15 ns (10% to 90%).
Total Aberrations:
5% of full amplitude (each peak of waveform).

Time Symmetry
Square Wave Variation From 0.1 to 2 on Dial:
<±1% to 200 kHz.
<±10% to 20 MHz.

Triangle Linearity
0.002 Hz to 200 kHz: >99%.

AUXILIARY GENERATOR

Waveforms
Selectable ∿, △, ⊓, ◿ and ⊓. Symmetry of ◿ and ⊓ adjustable 1:19 thru 19:1.*

Frequency Range
0.1 Hz to 100 kHz in 4 ranges.*

Auxiliary Output
Waveforms selectable and variable to 10 Vp-p (5 Vp-p into 600Ω).

Auxiliary Sync Output
Rear panel BNC. TTL level pulse coincident with AUX GEN output. Duty cycle varies with symmetry control.

AUX VCG Input
Rear Panel BNC. Up to 33:1 frequency change with external ±5V signal. Upper frequency limited to maximum of selected range. 11 kΩ input impedance.

MODES OF OPERATION

Internal auxiliary generator used as the modulation source.

FM
Two setup and one operate mode.
Set-Freq/Aux-Gen-Off: Disables auxiliary generator for main generator adjustment.
Set ΔF: Allows vernier setup of peak deviation. Vernier range is up to ±10% of main generator range.
FM: Operate mode.

Sweep
Two setup and one operate mode.
Set Start: Allows setup of main generator start frequency.
Set Width: Allows vernier setup of main generator stop frequency.
Sweep: Operate mode.

AM
Two setup and one operate mode for double sideband or suppressed carrier operation.
Set Carrier: Allows setup of carrier amplitude.
Set ΔM: Allows the setup of the modulation level.
AM: Operate mode. 0 to 100% AM or suppressed carrier modulation of main generator by auxiliary generator plus external signal if present at AM IN.
Aux Out Only: Disconnects the modulator for independent operaton of auxiliary generator.

GENERAL

Stability
Amplitude, frequency and dc offset at FUNC output after 2 hour warm-up:
±0.05% for 10 minutes.
±0.25% for 24 hours.

Environment
Specifications apply at 23° ±5°C. Operates from 0° to +50°C.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 28.6 cm (11¼ in.) deep.

Weight
4.6 kg (10 lb) net; 5.9 kg (13 lb) shipping.

Power
100/120/220/240V (+5%, −10%), 48 to 66 Hz, ≤70 VA.

NOTE: All Specifications apply from 0.1 to 2.0 on frequency dial, when FUNC OUT amplitude is max and 50Ω terminated, and with SYM control OFF.

SYMMETRY and VERNIER controls affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

*In ◿ and ⊓ modes, indicated frequency is divided by approximately 10

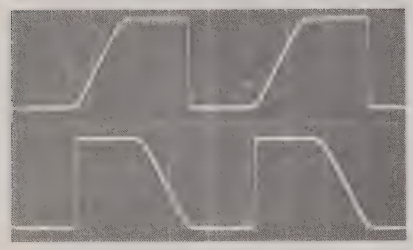
FACTORY/FOB

San Diego, CA

PRICE

Model 193	**$1495**

30 MHz Sweep Generator



- 30 μHz to 30 MHz Frequency Range
- Variable Rise and Fall Times
- Trapezoidal Waveforms
- Trigger and Gated Operation
- Sweep Up or Down

30 μHz to 30 MHz Frequency Range
Model 164 provides an extremely wide frequency range for both high and low frequency applications, 30 μHz to 30 MHz. This broad range will cover many of your generator applications.

Model 164 is a function generator with full trigger and gate capability as well as a sweep generator with internal sweep and step sweep.

Variable Rise and Fall Time
For pulse applications, Model 164 provides positive, negative and balanced pulse outputs. Duty cycle, rise and fall times and dc offset levels of these outputs are all independently variable.

Trigger and Gated Operation
Single cycles or "bursts" of cycles of the selected waveform can be produced by triggering the generator with an external signal or with the manual front panel switch. Trigger start/stop point can be adjusted to give haversine outputs as well as complex waveforms.

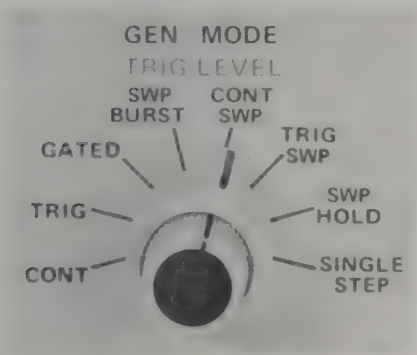
Sweep Up or Down
Besides the conventional low-to-high frequency sweep, Model 164 will sweep high-to-low. Sweep width is fully adjustable to 1000:1 and sweep time is continuously adjustable from 10 microseconds to 100 seconds. Sweep hold mode stops the generator at the sweep limit so that you can easily and accurately adjust the total sweep width.

Incremental Frequency Steps
Step sweep is another sweep mode on the Model 164. The sweep width is divided into 10 steps, giving 11 frequencies. You can step sweep through 11 frequency steps automatically or make one step with each press of the manual trigger switch. Steps can be up or down in frequency.

VERSATILITY

Waveforms
Sine ∿, square ⊓, triangle △, positive square ⎍, negative square ⎌, trapezoid ⏢, positive trapezoid ⏢, negative trapezoid ⏢, ramp ◿ and stair step (up and down) ⟋.

Operational Modes
Continuous: Main generator oscillates continuously at selected frequency.
Triggered: Generator quiescent until triggered by an external signal, then generates one cycle at selected frequency.
Gated: As triggered mode, except main generator oscillates for the duration of the external signal. Last cycle started is completed.
Continuous Sweep: Recurring low-to-high or high-to-low frequency oscillations. Range and rate selectable.
Triggered Sweep: Low-to-high or high-to-low frequency oscillation with each trigger input; then returns to initial frequency after sweep.
Sweep Hold: Sweep from start frequency to stop frequency and continued oscillation at stop frequency.
Sweep Burst: Main generator quiescent until gated, then in sweep hold mode for duration of gate; return to quiescent state when gate signal is removed.
Single Step: Main generator steps to next frequency with each trigger in stair sequence. After 10th step, returns to initial frequency.



Mode Control

Frequency Range
0.00003 Hz to 30 MHz in 11 decade ranges with dial and frequency vernier.

Main Output
∿, ⏢, ⊓ and △ selectable and variable to 20 Vp-p (10 Vp-p into 50Ω). ⎍, ⎌, ⏢ and ⏢ to 10V peak (5V peak into 50Ω). DC voltage adjustable to ±10V, 50Ω source. Output peak current is 100 mA minimum for all waveforms and dc. 0 to 60 dB attenuation in 10 dB steps with a 20 dB vernier; maximum overall attenuation 80 dB. High level 0 to −50 dB and low level −40 to −80 dB outputs.

DC Output and DC Offset
Waveform offset and dc output selectable through 50Ω outputs. Adjustable between ±10V (±5V into 50Ω). DC offset and output waveform are attenuated proportionately by the attenuator.

Sync Output
Approximately 0 to +4V into open circuit; 50Ω source. Rise and fall times typically 10 ns into 50Ω. Sync waveform normally square is rectangular with SYMMETRY control on.

Sweep
Sweep/Step Time: 10 μs to 100s in 7 ranges selectable.

Sweep Output
Sweep Signal: 0 to +5V ramp or stair step.
Source Impedance: 600Ω.

GCV—Generator Control Voltage
0 to +5V output proportional to main generator frequency
Source Impedance: 600Ω.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ±5V signal. Upper frequency is limited to maximum of selected range.
Input Impedance: 5 kΩ.
Slew Rate: 2% of range per μs.
Linearity: ±0.5% for 0.0003 Hz to 3 MHz.

Symmetry Control
Symmetry of all waveform outputs is continuously adjustable from 1:19 to 19:1. Varying symmetry provides variable duty cycle pulses, sawtooth or nonsymmetrical trapezoidal waveforms.

NOTE: When SYMMETRY control is used, indicated frequency is divided by approximately 10.

Slope and Width Control
For trapezoidal waveforms ⏢, ⏢ and ⏢ only. Ratio of period to rise or fall time is variable from 2:1 (triangle) to greater than 100:1 with 12 ns minimum rise and fall time.

Trigger and Gate
Input Range: 1V p-p to ±50V.
Impedance: 10 kΩ, 33 pF.
Pulse Width: 25 ns min.
Repetition Rate: 20 MHz max.
Adjustable Triggered Signal Start/Stop Point Approximately:
−90° to +90° to 3 MHz.
−90° to 0° for 3 to 30 MHz.

FREQUENCY PRECISION

Dial Accuracy
±(1% of setting +1% of full scale) or 0.0003 Hz to 300 kHz.
±(3% of setting +2% of full scale) for 300 kHz to 30 MHz.

Time Symmetry
±0.5% for 30 Hz to 300 kHz.
±1.0% for 0.0003 to 30 Hz.

AMPLITUDE PRECISION

Amplitude Change With Frequency
Sine variation less than:
±0.1 dB to 300 kHz.
±0.2 dB to 3 MHz.
±2.5 dB to 30 MHz.

Amplitude Symmetry
1% of amplitude range to 3 MHz.

Step Attenuator Accuracy
±0.25 dB per 10 dB step.

WAVEFORM CHARACTERISTIC

Sine Distortion (Continuous Mode)
<0.5% for 10 Hz to 100 kHz.
<1.0% for 0.0003 Hz to 300 kHz.
All harmonics at least 26 dB down to 30 MHz.

Triangle Linearity
Greater than 99% for 0.0003 to 300 kHz.

Square Wave Rise and Fall Time
Less than 12 ns terminated into 50Ω load.

Total Aberrations
Less than 5%.

GENERAL

Stability
Amplitude, dc offset and frequency.
Short Term: ±0.05% for 10 minutes.
Long Term: ±0.25% for 24 hours.

Environment
Specifications apply at 23° ±5°C. Instrument will operate from 0° to +55°C.

Dimensions
36.8 cm (14½ in.) wide; 13.3 cm (5¼ in.) high; 34.3 cm (13½ in.) deep.

Weight
6.8 kg (14.9 lb) net; 8.6 kg (19 lb) shipping.

Power
90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 50 VA.

NOTE: Specifications apply from 10 to 100% of a selected frequency range with SYMMETRY control at OFF. Symmetry and vernier affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

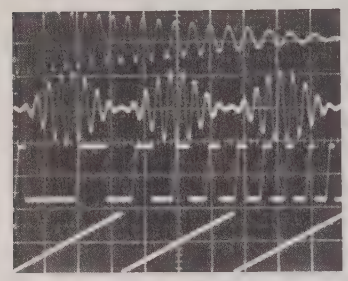
FACTORY/FOB

San Diego, CA

PRICE

Model 164 **$2295**

50 MHz Pulse/Function Generator



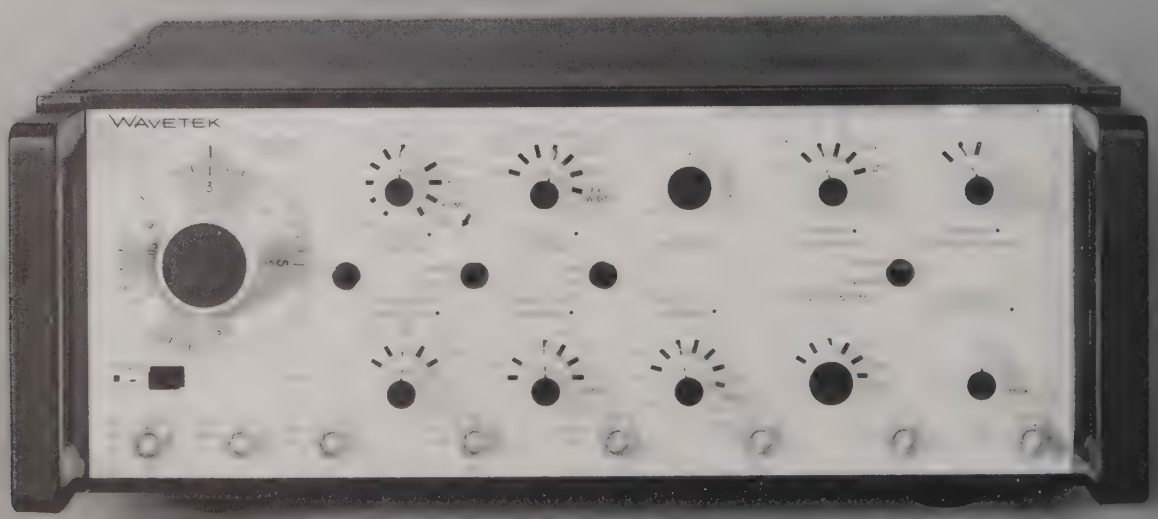
- 0.0001 Hz to 50 MHz Range
- 30 Volt Peak-To-Peak Output
- Lin/Log Sweep Plus AM and FM
- Pulse Width and Transition Time Control
- Independent Pulse Width and Rate

Pulse and Functions
The Model 166 Pulse/Function Generator fills your requirement for a truly versatile laboratory instrument. It is a swept sine, square and triangle function generator for your analog applications and a pulse generator with width and transition control for your digital testing requirements. And for all its versatility, the Model 166 controls, clustered for function, are readily understandable and direct-acting.

0.0001 Hz to 50 MHz Range
The frequency range of 0.0001 Hz to 50 MHz gives you the frequency and repetition rates in greater ranges than normally found in function or pulse generators alone. The sine, triangle, square, haverwave and ramp waveforms and the pulses can be output in a variety of mode of triggering and sweep.

You can tailor Model 166 pulses for your testing requirements. Pulses are fully shape controlled in amplitude, width and transition times. Simultaneously with the variable pulse output, TTL and $\overline{\text{TTL}}$ pulse outputs give you automatic logic-compatible pulses. An external width mode lets you reconstruct external pulses for logic conversion or noise removal.

AM and FM
To round out the versatility of the Model 166, the output pulse as well as the functions can be amplitude and frequency modulated with an AC signal or amplitude and frequency controlled with a remote DC signal. Amplitude modulation can be to 200% for suppressed carrier operation.



MODEL 166 FUNCTION GENERATORS

VERSATILITY

Instrument operates as a sweep/function generator or a pulse generator.

SWEEP/FUNCTION GENERATOR

Selectable Waveforms
Sine ∿, triangle △, square ⊓ and ramp ◿. All can be inverted. All can be amplitude and frequency modulated.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.
Triggered: Generator quiescent until triggered by external signal or manually, then generates one cycle.
Double Triggered: As triggered, except two cycles are generated.
Triggered Haverwave: As triggered mode. Output is one cycle starting at −90° (or +90°).
Gated: As triggered, except output continues for duration of gate.
Gated Haverwave: As gated. Output is a burst of cycles starting at −90° (or +90°).
Continuous Sweep: Generator frequency continuously sweeps up from start to stop frequency.
Triggered Sweep: Generator oscillates at sweep start frequency until triggered, then generates one sweep to the stop frequency and returns to the start frequency.
Sweep and Hold: As triggered sweep mode, except the generator remains at stop frequency until the trigger signal falls, then returns to start frequency.

Frequency Range
0.0001 Hz to 50 MHz in 11 ranges. Maximum sweep 1000:1 in lin or log.

Sweep Time Range
100s to 100 μs in 6 ranges.

Function Output
Variable to 30 Vp-p (15 Vp-p into 50Ω). Voltage attenuation 0 to 80 dB: to 60 dB in 20 dB steps, plus 20 dB continuous vernier.

Low Frequency Hold
Function output will hold at the instantaneous voltage level when the hold switch is depressed. Effective in the 0.001 Hz to ×10 Hz ranges.
Amplitude Drift: Less than 0.2% of amplitude per minute.

DC Offset
DC offset of all waveforms is adjustable to ±10V (±5V into 50Ω). Waveform plus offset is limited to ±15V (±7.5V into 50Ω).

GCV Output
0 to +5V (nominal, open circuit) proportional to frequency of main generator.
Output Impedance: 600Ω

Sweep Output
0 to +5V (nominal, open circuit) ramp.
Output Impedance: 600Ω.
Sweep Time: 100s to 100μs.

VCG (FM)—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to +5V signal.
Mode: Linear or logarithmic.
Slew Rate: 2% of range per μs.
VCG Linearity: 0.0005 Hz to 50 kHz ±0.5% of range.

Voltage Controlled Amplitude (VCA)
0 to ±5V gives 0 to 30V amplitude change. AC input allows 0 to 200% modulation (suppressed carrier).
AC input Range: 5V minimum for 100%, 10V minimum for 200% AM.
Input Impedance: 4.99 to 10 kΩ, depending on gain control.
Input Bandwidth: 10 kHz.

Trigger Input
Trigger Signal: 1 Vp-p minimum.
Trigger Level: ±5V.
Input Impedance: 1.5 kΩ, 30 pF.
Maximum Repetition Rate: 25 MHz.

FREQUENCY PRECISION

Dial Accuracy
(For ∿, △, ⊓ and linear dial setting of 0.5 to 5.)
±2% of full scale for 0.0005 Hz to 5 MHz.
+15%, −6% of full scale for 5 to 50 MHz.

AMPLITUDE PRECISION

Amplitude Change With Frequency
Sine and square variations less than:
±0.1 dB to 100 kHz;
±0.2 dB to 1 MHz;
±3 dB to 50 MHz.

Step Attenuator Accuracy
±0.3 dB to 20 dB step to 100 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion (Test at 10 Vp-p)
Less than:
0.5% for 10 Hz to 50 kHz.
All harmonics greater than:
30 dB down for 50 kHz to 5 MHz;
20 dB down for 5 to 50 MHz.

Triangle Linearity
Greater than:
99% for 0.005 Hz to 100 kHz.

Square Wave Aberrations (Test at 10 Vp-p)
Less than 5% of p-p voltage.

PULSE GENERATOR

Pulses
Variable amplitude positive or complementary pulses ⊔, ⊓. Pulse amplitude, width and rise/fall times are independently adjustable and independent of frequency. TTL and $\overline{\text{TTL}}$ pulses are simultaneous with main pulse. Pulses may be amplitude and frequency modulated. All pulses can drive 50Ω terminations.

Operational Modes
Continuous, Triggered, Double Triggered, Gated and Continuous Sweep. (See Sweep/Function Generator).
External Width: An external signal at the trigger input determines the output pulse width and period.

Pulse Period Range
Pulse period is selectable from 20 ns to 10,000s (50 MHz to 0.0001 Hz) with approximately 1% vernier.

Pulse Width
10 ns to 100 ms in 7 ranges. Maximum duty cycle is 70% for periods to 200 ns, decreasing to 50% for 20 ns periods. Control has nominal 50% duty cycle detent.

Transition Time
7 ns to 50 ms in 7 ranges, independently variable for leading and trailing edges.

Function Output
0 to ±15V into open circuit (0 to ±7.5V into 50Ω). Voltage attenuation 0 to 80 dB: to 60 dB in 20 dB steps, plus 20 dB continuous vernier.

TTL and $\overline{\text{TTL}}$ Pulses
Transition times less than 4 ns into 50Ω termination.

GENERAL

Stability
Amplitude, dc offset and frequency in linear mode to 500 kHz.
Short Term: ±0.05% for 10 minutes.
Long Term: ±0.25% for 24 hours.

Environment
Specifications apply at 23° ±5°C after 30 min warm-up. Instrument operates from 0° to +50°C.

Dimensions
36.2 cm (14¼ in.) wide; 13.3 cm (5¼ in.) high; 38.1 cm (15 in.) deep.

Weight
8.8 kg (19.4 lb) net; 10.9 kb (24 lb) shipping.

Power
90 to 105V, 108 to 126V, 198 to 209V and 216 to 252V; 50 to 66 Hz; 50 VA nominal.

FACTORY/FOB

San Diego, CA

PRICE

Model 166	**$2495**

Programmable Waveform Synthesizer

- 1 μHz to 50 MHz Frequency Range
- Synthesized 8 Digit Accuracy
- Trigger, Gate, Burst, Lin/Log Sweep
- 20 Volts Peak-to-Peak Output into 50Ω
- Sine, Triangle, Square, Ramps, and DC
- Optional MATE Interface

High Performance Generator
Model 178 Waveform Synthesizer, a bench top or ATE programmable instrument, combines the precision of an 8 digit, 50 MHz synthesizer with the versatility of a function and sweep generator. In addition to sine and square wave to 50 MHz, Model 178 includes the useful triangle, ramps and haverwaves.

Innovative design gives synthesized triggering, gating, frequency sweep, burst counts and combinations of these modes for application flexibility. The output drives your 50Ω load to a full 20 volts peak-to-peak. The microprocessor design lets you program the level in convenient terms of Vrms, Vp-p or dBm.

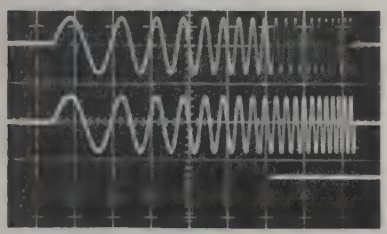
Careful software design has resulted in a flexible, easy to program format. You may implement a change of only one instruction or completely change all settings in a few milliseconds.

Additional features include amplitude and phase modulation, stored settings, variable waveform phase and programmable frequency markers.

Main Generator
Fifty megahertz synthesized performance to 8 digit resolution places your output precisely where you want it—and with a spectrally pure and accurate signal. Stimulus diversity includes the function generator waveforms of sine and square waves (less than 8 ns rise/fall) to 50 MHz, triangles to 500 kHz and ramps to 20 kHz. Useful haverwaves, based on sine or triangle waveforms, extend precision performance to include low frequency medical and mechanical stimulations.

Sweep Generator
Choose from linear or true log frequency sweeps, up or down and at virtually any sweep times. The sweeper may be operated by itself or combined with the main generator to provide continuous, triggered, gated, hold at start or stop, and even burst counted sweeps. Ten preset markers, available one at a time, flag critical sweep frequencies and provide start or stop triggers. Sweep is synthesized at all frequencies and

remains phase continuous even if the sweep is interrupted with a hold and later resumed.

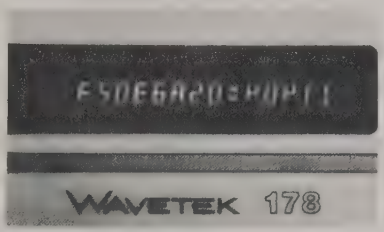


Sweep with Marked Frequency, Sweep without Marker, and Marker Pulse

Pulse
The 178 is a versatile pulse generator with precision pulses, available to a full ± 10 volt swing. Independent width and rate controls remain fully synthesized even in triggered, gated and burst operation.

Precision Output
Now you can drive your 50Ω load from as low as 1 millivolt to a full 20 volts peak-to-peak (flat even to 50 MHz), without the need for additional amplifiers. All waveforms may be combined with dc offset to the full ± 10V output window. Three digit amplitude and offset controls provide top performance in repeatability, accuracy and wideband flatness. Output is conveniently available either front or rear (selectable) and safely defaults to a 1 Vp-p level upon power-up and reset.

GPIB Compatibility
All of the 178's useful features may be programmed via the IEEE 488-1978 standard General Purpose Interface Bus (GPIB) system. Programming is just as easy as the GPIB as it is from the front panel. Any one parameter may be changed individually or several instructions may be entered for a simultaneous output change. Extremely high speed GPIB response and fast settling ensures fast ATE test times and greater production throughputs. For convenience, the GPIB coding string of recent manual and remote programming is displayed at a push of a button or placed on the bus in talker mode. Other GPIB features include expanded terminator characters, SRQ messages, error listings and sweep hold flags.



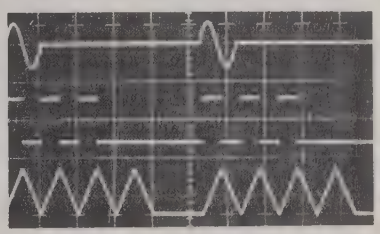
Programming String Display

Stored Settings
Time saving internal registers permit recall of complete instrument setups within milliseconds. Each setup may be loaded into any of the five storage areas of dynamic memory for later recall. Storage may be optionally expanded to forty additional registers with battery backup. Single commands permit rapid sequencing through all stored settings. Fast recall of stored settings is particularly well suited for repetitive testing both on the bench with front panel controls and also via the GPIB.

Amplitude Conversion
Enter and display amplitude entires in convenient volts peak-to-peak, volts rms or in dBm—all into 50Ω. The 178 performs these conversions automatically on any waveform.

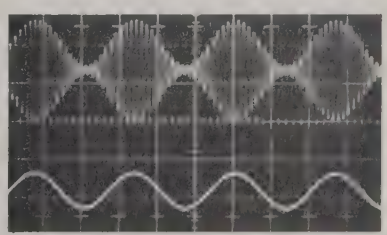
Variphase Synchronization
Incrementally shift the 178's main output in phase steps as fine as 0.01°. Locking the 178 synthesizer with another generator or external clock expands our stimulus capability to high resolution servo positioning and phase coherency.

Innovative Trigger
Trigger, gate and burst count (to 2^{16}) the 178's synthesizer up to 200 kHz rate. Full synthesizer performance guaranteed on all your stimulus applications.



Synthesizers Output in Triggered Burst Mode

Amplitude Modulation
In addition to all these features, the 178 may be externally phase modulated at any time or externally amplitude modulated up to 200 percent.



Sine Wave Amplitude Modulation

Optional MATE Interface

Model 178 is available with a factory-installed MATE interface per USAF Standard 2806763 (Option 010). The MATE interface consists of both hardware and software. The software accepts GPIB commands in Control Interface Intermediate Language (CIIL) as well as the "native" Model 178 language. The hardware includes expanded memory to support the additional software, shallower handles to allow the instrument to be mounted in a rack equipped with a front door, and a status monitor interface to report catastrophic failures to the control computer in real-time. The status monitor interface is independent of the GPIB.

MODEL 178 PROGRAMMABLE FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine ∿, square ⊓, triangle △, ramps ◿, ◺, haversine ⌒, ⌣, havertriangles ⌒, ⌣, AM (sine) ⋈, and DC.

Operational Modes
NOTE: All modes are synthesized.
Continuous: Generator runs continuously.
Triggered: Generator is quiescent until triggered by an external signal, internal sweep signal, GPIB or manual trigger, then generates one cycle at selected frequency.
Gated: As triggered mode, except generator oscillates for the duration of the gate signal plus the remainder of the waveform in progress.
Triggered Haverwave: As triggered mode, except output is a sine or triangle waveform starting at −90° (or +90°).
Gated Haverwave: As gated mode, except output is a sine or triangle waveform starting at −90° (or +90°).
Triggered Burst: As triggered mode, except the number of cycles output for each trigger input is selected from 1 to 65,536 (2^{16}) counts.
Triggered Haverwave Burst: As triggered burst, except output is a sine or triangle waveform starting at −90° (or +90°).
NOTE: See Frequency Range Section for frequency capability in each mode.
Frequency Sweep: Output frequency can be swept by internal sweep generator. (See Sweep Generator for sweep modes.)

Frequency Range
Low end for all waveforms is 1 μHz.
Continuous Mode:
∿, ⊓, ⋈ to 50 MHz.
△ to 500 kHz.
◿, ◺ to 20 kHz.
All Triggered Gated and Burst Modes:
∿, ⊓, △, ⋈ to 200 kHz.
◿, ◺ to 20 kHz.
Frequency Sweep: (See Sweep Generator).

Main Output
All waveforms are available to 20 Vp-p maximum into 50Ω load. Combined amplitude/dc offset not to exceed ±10V peak into 50Ω. Output voltage into an open circuit is double indicated voltage when a voltage less than ±5V peak is selected. Output available on front or rear (selectable) BNC.
Phase Offset: Output phase may be changed to any angle in 0.01° resolution steps to 500 kHz and 0.1° (or better) resolution steps above 500 kHz.

Amplitude Conversion
Permits entry and display of amplitude for all waveforms in units of Vrms, Vp-p and dBm, all into 50Ω load.

DC Offset and DC Voltage Output
0 to ±10 Vdc into 50Ω. Output voltage is double into open circuit when voltage less than ±5 Vdc is selected. DC offset is attenuated by the amplitude range attenuator.

Auxiliary Outputs
TTL and $\overline{\text{TTL}}$ Sync Outputs: At generator frequency, 50Ω source impedance, 50% duty cycle. Less than 5 ns transition time.
Sweep Ramp Output: (See Sweep Generator).
Reference Output: 10 MHz, 1 Vp-p sine, 50Ω source impedance.
Frequency Marker Output: (See Sweep Generator).

Inputs
Trigger Input: A TTL level transition can trigger or gate both main generator and internal sweep generator. Triggering slope up (⌒) or down (⌣) is selectable.
Reference Input: An external 0.5V to 10 Vp-p sine or pulse clock of ±5 ppm or better stability and accuracy automatically locks the internal reference. External clock may be 1, 2, 3, . . . 9 or 10 MHz. A message "REFERENCE NOT LOCKED" is displayed if external reference is present but internal reference is not synchronized to it. Input impedance is 1 kΩ.
Amplitude Modulation Input: Rates from DC to 10 MHz minimum. Input impedance is 600Ω. 5 Vp-p input gives 100% modulation. Main output halved with no modulation. 200% modulation permitted. Sync output not affected by modulation.
Phase Modulation: Rates from DC to 10 kHz minimum. Input impedance is 10 kΩ. ±5V input delivers approx. ±360° shift. Output deviation is ÷100 for main output frequencies 500 kHz and below.

Data Entry
Front panel keyboard with display and GPIB programming.

MAIN GENERATOR

FREQUENCY RESOLUTION

8 digits or 1 μHz.

FREQUENCY PRECISION

Accuracy
Better than 0.0005% of program setting, ±0.01 μHz.

Stability
Long Term: $\pm 1 \times 10^{-6}$ of frequency per month.
Temperature: 1.2×10^{-7} per °C.

Signal to Phase Noise
Greater than 46 dB in a 30 kHz band centered on carrier but excluding a ±1 Hz band around the carrier.

Spurious
−60 dBc or 30 μV whichever is greater, 1 μHz to 500 kHz.
−50 dBc or 30 μV whichever is greater, 500 kHz to 50 MHz.

AMPLITUDE PRECISION

Resolution and Accuracy
Specified for 1 kHz sine wave, or for dc output into a precision 0.1% 50Ω load.
NOTE: DC offset range is 0 to ±10 Vdc.

Amplitude Range	Accuracy (Amplitude)
10.02 to 20.00 Vp-p	±1% ± 20 mV
1.01 to 10.0 Vp-p	±1% ± 10 mV
0.101 to 1.00 Vp-p	±3% ± 2 mV
10.1 to 100 mVp-p	±4% ± 100 μV
1.00 to 10.0 mVp-p	±5% ± 20 μV

Resolution: 3 digit, less than or equal to 10.0 Vp-p. 4 digit (20 mV), greater than 10Vp-p.
DC Offset: ±1% of setting ±40 mV (worst case).
NOTE: Amplitude and dc offset share the output attenuator.

Frequency Response
Specified relative to 1 kHz sine wave.

Frequency Range	Response
1 μHz to 20 kHz	±1%
20 kHz to 500 kHz	±3%
500 kHz to 25 MHz	±7%
25 MHz to 50 MHz	±15%

NOTE: ⊓, ∿ add 1% to above ◿, ◺ add 5%.

Amplitude and Offset Stability
Measured at room temperature.
Short Term: 0.1% for 10 min.
Long Term: 0.5% for 6 months.

WAVEFORM CHARACTERISTICS

Sine Distortion
Specified for 1 Vrms (2.82 Vp-p) sine wave. Harmonically related signals less than:
−55 dBc to 50 kHz.
−40 dBc to 500 kHz.
−30 dB to 50 MHz.

Square Wave Rise and Fall Time
Less than 8 ns, 1.01 to 10.00 Vp-p.
Less than 10 ns, greater than 10 Vp-p.

SWEEP GENERATOR

Sweep generator is fully synthesized and may be used independently or for frequency sweeping and triggering the main generator. Frequency sweep may be selected linear or logarithmic, and up or down. Sweep may be triggered, gated, burst, interrupted with hold, and continued with resume.

SWEEP MODES

Continuous Sweep: Sweep generator sawtooth runs continuously.

Triggered Sweep: Incoming trigger causes a single sweep and reset to start frequency.

Triggered Sweep/Triggered Reset: As in triggered sweep, but sweep ends at stop frequency. Next trigger returns frequency to start.

SWEEP CHARACTERISTICS

Sweep Time
0.01 to 600.00s, 0.01s resolution.

Sweep Output
0 to +5V ramp synthesized to 2000 steps per sweep. 600Ω output impedance.

Frequency Marker Output
TTL levels. One of the ten preset markers can be selected. Output is low when the main generator frequency is below marker frequency; output is high when above.

Maximum Sweep Range
Low Band: 1 μHz to 500 kHz.
High Band: 5 kHz to 50 MHz.

Minimum Sweep Range
Log: Any start and stop frequencies with ratio greater than 2.
Linear: Any start and stop frequencies with a minimum separation of:
Low Band: 200 mHz per 1s of sweep time.
High Band: 2 Hz per 1s of sweep time.

Sweep Resolution
Frequency Resolution including Start, Stop, Hold, Markers: 8 digits or 1 μHz.
Frequency Update: Every 5 μs (lin and log).
Log Slope Update: Every 2 ms.

PULSE

Fully synthesized. Pulse period and width parameters entered by sweep time and main generator frequency respectively. Includes continuous, single, burst, gated and complement pulses.

Period
10 μsec to 600s (10 min.);
4 digit resoution (sweep time control);
Less than 1% jitter.

Width
5 μs to 500,000s (5 days); 8 digit resolution (frequency control);
Less than 0.05% jitter.

NOTE: Width usable to 1 μs.

GENERAL

Stored Settings
Up to 5 complete instrument setups can be stored and recalled by number from volatile (RAM) memory. Settings may be modified or deleted.

GPIB Programming
Standard Purpose Interface Bus (GPIB) programming per IEEE Standard 488-1978. Interface is optically isolated from signal ground. Interface includes Listener (AH1 and L4), Talker (SH1 and T6), SRQ (SR1), Local Lockout (RL1), Device Clear (DC1), and Group Execute Trigger (DT1) Capabilities and Open Collector Logic (E1).

Parameter	Time
Command Handshake	15 μs
Data Handshake	65 μs
Frequency	11 ms
Amplitude	14 ms
DC Offset	14 ms
Mode	4 ms
Function	5 ms
Output	4 ms
Execute	8 ms

Environment
Accuracy applies for 25°C ±10°C after 30 minutes warm-up unless otherwise noted. Instrument will operate from 0°C to 50°C, to 10,000 ft altitude and to 90% relative humidity. Storage temperature from −25°C to +65°C.

Dimensions
44.5 cm (17.5 in.) wide; 13.3 cm (5¼ in.) high; 53.4 cm (21 in.) deep. Supplied with rack mount adapters.

Weight
14.7 kg (32.4 lb) net; 18.2 kg (40 lb) shipping.

Power
90 to 105V, 108 to 126V, 198 to 231V or 216 to 252V; 48 to 67 Hz; less than 180 watts.

OPTIONS

001: Additional Stored Settings
Provides nonvolatile memory for up to 40 additional stored settings. Memory is battery backed up (internall recharged) for 60 day (minimum) retention of settings.

002: High Stability Frequency Reference
An additional frequency reference crystal for greater accuracy. Standard or High Stability crystal selectable by rear panel switch.
Accuracy: $\pm 5 \times 10^{-8}$.
Aging Rate: 5×10^{-9}/day (average), $<4 \times 10^{-8}$/week.

010: MATE Interface
Factory installed MATE interface per USAF Standard 2806763.

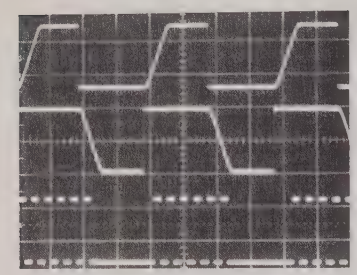
FACTORY/FOB

San Diego, CA

PRICE

Model 178	**$5650**
Option 001	**$795**
Option 002	**$795**
Option 010	**$3250**

50 MHz Pulse Generator



- **5 Hz to 50 MHz Frequency Range**
- **Variable Rise and Fall Times**
- **Full 20 Volt Output**
- **Single and Double Pulses**
- **Pulse Burst Output**

Multiple Outputs
The output circuits give you a variable amplitude pulse and, simultaneously, ECL, $\overline{\text{ECL}}$, TTL and sync pulses. The upper and lower levels of the variable pulse are independently adjustable from −20 to +20 volts. The maximum output is a full 20 volts peak-to-peak. All outputs, the four fixed and one variable can be used simultaneously.

Triggering
Operating modes include continuous, triggered, gated, burst and external width. The external width mode allows you to reconstruct a noisy external pulse. Triggering is by front panel switch or an external signal. A front panel LED indicates trigger acceptance so you will know when the generator is receiving a valid trigger input. You can trigger and gate on the rising or falling edge of the trigger signal and adjust the acceptable trigger signal level.

Variable Rise and Fall
The rise and fall transition times of the pulse can be independently adjusted. The range of control is from 7 ns to 250 ms. Independent width and rate controls ensure that the 801 can generate the pulse that you need for your testing requirements.

Pulse Burst Output
The pulse burst capability of the 801 lets you generate variable length pulses. In this mode, an external trigger signal will start the output of the 801. The delay control lets you easily and accurately adjust the number of pulses that the generator will produce.

VERSATILITY

Five Simultaneous Pulse Outputs: Fixed level ECL, $\overline{\text{ECL}}$, TTL and sync pulses and a pulse with variable amplitude and variable rise/fall times. 5 Hz to 50 MHz frequency range (200 ms to 20 ns periods).

Operational Modes

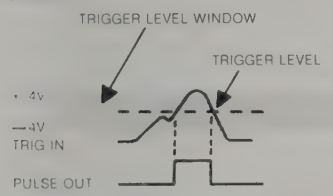
Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator quiescent until triggered by external signal or manually, then generates one pulse.

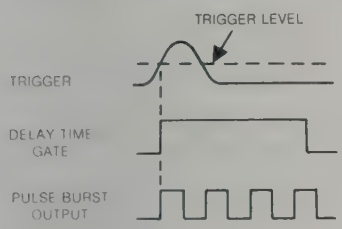
Gated: As triggered mode, except generator oscillates for the duration of the external signal.

Double Pulse: Continuous, trigger and gate as above, except two pulses for each period. Space between pulses of double pulse controlled by delay control. Double pulse at all outputs except sync.

External Width: External signal at trigger input and trigger level control determine output pulse width and period as shown.



Trigger Burst: External trigger starts internal gate (delay time) for pulse burst as shown.



PULSE OUTPUTS

Pulse Controls

Variable Amplitude Pulse

Upper and lower pulse levels are independently adjustable.

Source Impedance: 50Ω.

Into Open Circuit:

Pulse Dynamic Range: ±20V.
Max Pulse: 20 Vp-p.
Min Pulse: 1 Vp-p.

Into 50Ω Termination:

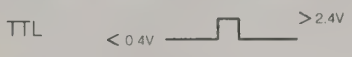
Pulse Dynamic Range: ±10V
Max Pulse: 10 Vp-p.
Min Pulse: 0.5 Vp-p.

Overshoot and Ringing: <±(5% of amplitude setting +100 mV) into 50Ω load.

Preshoot: <±(5% of amplitude setting +100 mV) into 50Ω load.

Fixed TTL Pulses

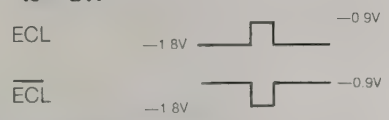
Pulse Levels for 50Ω Loading:



TTL Transition Time: <10 ns.

Fixed ECL, $\overline{\text{ECL}}$ Pulses

Pulse Levels with 50Ω Termination into −2V:



ECL, $\overline{\text{ECL}}$ Transition Time: <6 ns.

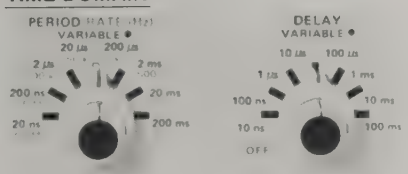
Sync Pulse

Sync pulse is 0 to at least +1V from a 50Ω source.

Normal/Complement Control

Normal pulse or its complement is selected. The normally quiescent and active levels are reversed in complement format. This control affects all outputs except sync pulse.

TIME DOMAIN



Period and Delay Controls

Period Range: <20 ns to >200 ms in 7 overlapping ranges.

Period Jitter: <0.1% plus 50 ps.

Width

Width Range: <10 ns to 100 ms in 7 overlapping ranges.

Max Duty Cycle: 70% for periods down to 200 ns, decreasing to 50% for 20 ns periods. Range switch also has a square wave detent (⊓).

Duty Cycle: 50 ±4% to 2µs period changing to 50 ±15% at 20 ns period.

Width Jitter: <0.1% plus 50 ps.

Sync Pulse Duty Cycle: 50 ±4% of pulse period to 2µs period. Changes to 50% ±15% at 20 ns, except in trigger and external width modes, where it is determined by the trigger signal.

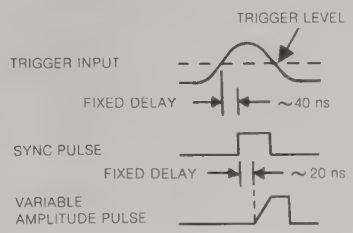
Delay

Pulse occurrence can be delayed from approximately 20 ns to 100 ms with respect to the sync pulse (not including fixed delay).

Max Duty Cycle: 70% for periods down to 200 ns, decreasing to 30% for 20 ns periods.

Delay Jitter: <0.1% plus 50 ps.

Fixed Delay:



Transition Time

For variable amplitude pulse only. Independently adustable leading and trailing edges from <7 ns (5 ns typical) to 250 ms in 7 overlapping decade ranges (measured from 10 to 90% points). Verniers give 50:1 adjustment on all ranges except 5 ns, which gives 25:1.

Linearity: ±5% for transition >10 ns, measured between 10 and 90% points on pulse.

INPUT CHARACTERISTICS

External Trigger

Min Amplitude: 200 mVp-p to 5 MHz increasing to 600 mVp-p to 50 MHz (from 50Ω source).

Max Amplitude: ±10V.

Min Width: 10 ns.

Input Impedance: 1 kΩ in parallel with 22 pF.

Triggering is selected to occur at either rising or falling edge of trigger signal; triggering level is adjustable to be between ±4V. An LED lights for approximately 100 ms for each external and manual trigger occurrence accepted.

GENERAL

Environment

Specifications apply at 23° ±5°C after 1 hour warm-up. Instrument will operate from 0° to 50°C

Dimensions

28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 29 cm (11¼ in.) deep.

Weight

5.4 kg (12 lb) net; 6.8 kg (15 lb) shipping.

Power

90 to 130V or 180 to 250V; 50 to 400 Hz; 60 watts nominal.

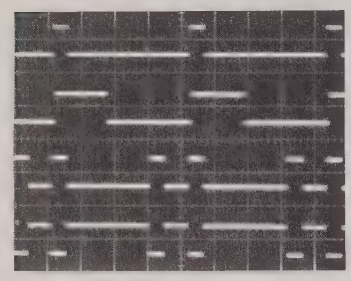
FACTORY/FOB

San Diego, CA

PRICE

Model 801 **$1495**

50 MHz Pulse Generator



- 5 Hz to 50 MHz Repetition Range
- Variable Width and Delay
- Full 10 Volt Output
- Four Simultaneous Outputs
- Five Nanoseconds Rise/Fall Times

Adjustable Upper and Lower Levels
You can adjust the pulse upper and lower levels independently and directly. Amplitude and dc offset do not interact. This feature frees you from tedious readjustment and tuning when you are setting up a given pulse.

Selectable Source Impedance
For optimum loading, an internal 50 ohm termination is selectable at the 802 output. Placement of the 50 ohm termination at the source, at the load, or both gives you additional versatility in minimizing aberrations due to reflections.

Multiple Outputs
In addition to the variable ± 10V output, the Model 802 gives you fixed TTL and $\overline{\text{TTL}}$ outputs. You can use these convenient fixed outputs with your most commonly used logic, TTL, and never adjust amplitude, or you can have simultaneous outputs at fixed and variable levels for further versatility and performance

Independent Rate, Width and Delay Control
Repetition rate, width and delay can all be independently adjustable. Delay and width controls each have a blank detent for your custom range. This allows you to select your most often required pulse values quickly and repeatably. You can use the Model 802 in the continuous, trigger, gate and external width modes with normal delayed or double pulse outputs, for further operating versatility and performance.

VERSATILITY

Four Simultaneous Pulse Outputs

Fixed TTL level sync, TTL and $\overline{\text{TTL}}$ outputs and variable amplitude output pulses are available over a 5 Hz (200 ms) to 50 MHz (20 ns) frequency range.

For optimum pulse characteristics from the variable amplitude pulse output, an internal 50Ω load can be selected via a front panel control.

Operational Modes

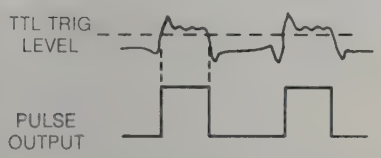
Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator quiescent until triggered by external TTL pulse or front panel control, then generates one pulse.

Gated: Generator oscillates at the period rate selected by the front panel control when gate input is high. Generator quiescent when input is low. First cycle is synchronous with rising edge of gating signal.

Double Pulse: Continuous, triggered and gated, as above, except two pulses for each period. Time to second pulse is controlled by delay control. Double pulse at all outputs except sync.

External Width: External signal at trigger input determines output pulse width and period as shown.



PULSE OUTPUTS

Variable Amplitude Pulse

Upper and lower pulse levels are independently adjustable. Pulse dynamic range is ±10V when load is 50Ω terminated and source is not (internal 50Ω off) or vice versa. Maximum pulse amplitude is 10V; minimum is 1V.

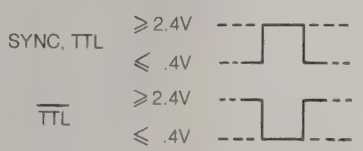
Level Controls

Dynamic range and pulse amplitude are decreased by a factor of 2 when source and load are 50Ω terminated. Overshoot and ringing are less than (±5% of amplitude setting + 100 mV) when terminated into 50Ω at both load and source. Transition times are less than 5 ns.

SOURCE	LOAD	DYNAMIC RANGE	AMPLITUDE MAXIMUM	AMPLITUDE MINIMUM
50Ω	50Ω	+5V −5V	5V	.5V
1 kΩ OR 50Ω	50Ω OR ≥1kΩ	+10V −10V	10V	1V

Sync TTL and $\overline{\text{TTL}}$ Pulses

TTL, $\overline{\text{TTL}}$ pulse levels into 50Ω termination; sync pulse level from 50Ω source.



Transition times less than 7 ns into 50Ω termination.

Normal/Complement Control

Normal pulse or its complement is selected. The normally quiescent and active levels are reversed in complement format. This control affects all outputs except sync pulse.

TIME DOMAIN

Period

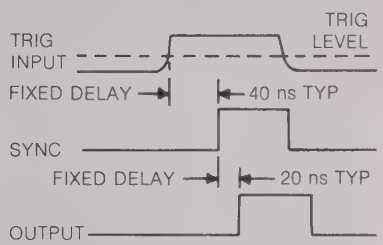
Period range is from less than 20 ns to greater than 200 ms in seven overlapping ranges. Period jitter is less than ±0.1% plus 50 picoseconds.

Width

Width range is from less than 10 ns to 10 ms in six overlapping ranges. Maximum duty cycle is 70% for periods to 200 ns, decreasing to 50% for 20 ns periods. Width selector switch also has a square detent and a customer-specified dentent.* ⊓⊔ duty cycle is 50 ±4% to 2 μs period, changing to 50 ±15% at 20 ns period. Width jitter is less than ±0.1% plus 50 picoseconds. Sync pulse duty cycle is 50 ±4% of pulse period to 2 μs period, changing to 50 ±15% at 20 ns period, except in trigger and external width modes, in which case it is determined by the trigger signal.

Delay

Pulse occurrence can be delayed from less than 10 ns to 10 ms with respect to the sync pulse (not including fixed delay). Delay selector switch also has a customer specified detent.* Maximum delay duty cycle is 70% for periods to 200 ns, decreasing to 30% for 20 ns periods. Delay jitter is less than ±0.1% plus 50 picoseconds. Fixed delay is as shown.



INPUT CHARACTERISTICS

External Trigger

The circuit receiving the external trigger is TTL compatible. Triggering level is fixed at approximately 1.4V. Input impedance is greater than 500Ω shunted by approximately 33 pF. Triggering and gating occur on the rising edge of the input signal.

GENERAL

Environmental

Specifications apply at 23° ±5°C after 30 minutes warm-up. Instrument will operate from 0° to 50°C.

Dimensions

28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 28.6 cm (11¼ in.) deep.

Weight

4.0 kg (8.9 lb) net; 5.4 kg (12 lb) shipping.

Power

108 to 132V or 216 to 250V; 50 to 400 Hz; 40 VA nominal.

*Customer-installed capacitor determines detent range

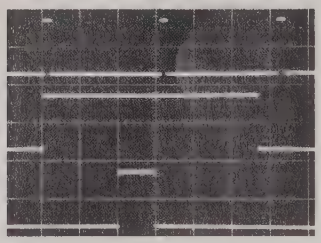
FACTORY/FOB

San Diego, CA

PRICE

Model 802 **$1095**

50 MHz Pulse Generator



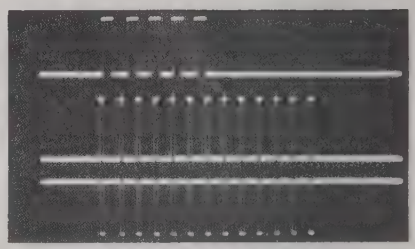
- **0.5 Hz to 50 MHz Frequency Range**
- **Full 20 Volt Output**
- **Variable Transition Times**
- **Second Channel Output Option**
- **GPIB and Stored Settings**

Wide Frequency Range
Model 859 provides 0.5 Hz (2s periods) to 50 MHz (0.02 μs periods), in a 5¼ inch high, rack mountable instrument that is fully programmable for systems applications.

Pulse Capabilities
Pulse widths can vary from 10 nanoseconds to 1 second, delays to 1 second, transition times from 5 nanoseconds to 25 milliseconds, and output levels up to 20 volts. All pulse parameters have a resolution of 3 digits. Extreme accuracy and microprocessor assisted programming ensure that the generator is producing exactly the pulse you want without having to verify its output. Output may be one pulse per period, double pulses or symmetrical square. Pulses may also be complemented.

Mode Versatility
Operating modes include continuous, triggered, gated burst (1 to 10,000 pulse periods), external width mode to reconstruct or shape an external signal, and unique time interval mode for extremely long pulses.

Trigger status is always shown. Front panel annunciators give positive indication of the selection of manual triggering (pushbutton or GPIB), external rising or falling edge triggering and of trigger presence.



Pulse Burst

Second Channel Option
Second channel output is available for dual pulse applications. Second

channel delay, width, function, transition times, output levels and complement parameters are fully indeendent of the first channel parameters. The two channels have common repetition rate and mode.

Double and Single Pulse

GPIB Programmable
Model 859 is fully compatible with the IEEE Standard 488-1978 for your General Purpose Interface Bus (GPIB) system. All parameters can be readily bus or manually programmed using the same simple prefix/ value notation. You are not tied to a rigid format. Any combination of numerals, floating decimal points and exponents that can express values will be correctly interpreted. The combination of LED annunciators and alphanumeric display easily verifies your setup, and in case of a programming error, an error message is displayed and the bus controller is informed.

Parameter Independence
You can vary a pulse parameter with full assurance that the other parameters remain exactly as programmed. We did not redefine the parameters in order to make them independently adjustable. For example pulse width is still measured at the 50% point (not leading edge to trailing edge start) and, yes, it remains constant as the transition times are varied, or pulse height, or frequency, or any other programming parameter. If your new parameter value is not compatible with the existing setup you are informed by an error message on both the display and the bus.

False Errors Eliminated
When programming a new setup, error checking is delayed until the entire set of new parameters has been entered and executed. You do not have to concern yourself with the order in which you program a setup to avoid tedious false errors.

Stored Settings
Operation is further simplified through stored settings and vernier features standard in the Model 859. You can store and recall up to 25 complete setups in battery-backed RAM which can eliminate the need for a controller in repetitive tests.

Rapid Incrementing
Vernier controls increment or decrement a single parameter value at a rate determined by positioning the front panel cursor to the digit to be modified. Vernier control eliminates repetitive rekeying of values when you are determining exact limitations of a device under test.

Front Panel
Using the front panel keyboard and display is quite straight forward and makes pulse design and programming easily understood. The internal microprocessor "converses" with the operator via the front panel informing him of what is possible to program, what was programmed and when an error is made. The front panel display shows the parameter being programmed and its value. Adjacent to the parameter display, annunciators give the status of the 859's operating conditions. The 859 front panel lets you know what's happening.

Display and Annunciators

Optional MATE Interface

Model 859 is available with a factory-installed MATE interface per USAF Standard 2806763 (Option 010). The MATE interface consists of both hardware and software. The software accepts IEEE 488-1978 interface bus (GPIB) commands in Control Interface Intermediate Language (CIIL) as well as the "native" Model 859 language. The hardware includes expanded memory to support the additional software, shallower handles to allow the instrument to be mounted in a rack equipped with a front door, and a status monitor interface to report catastrophic failures to the control computer in real-time. The status monitor interface is independent of the GPIB.

VERSATILITY

Pulse Outputs

Four pulse outputs:
Variable main channel pulse;
A 2nd channel variable pulse (optional);
TTL compatible fixed sync pulse at lowest frequency in generation system;
Fixed symmetrical (approximately 50% duty cycle) clock output which follows repetition rate generator.

Pulse Functions

Single: One pulse each pulse period. Up to 50 MHz repetition rate.

Double: One pair of pulses each pulse period. Up to 25 MHz repetition rate. Both pulses have programmed width. Position of 2nd pulse set by delay control.

Square: Pulse is fixed symmetrical (50% duty cycle) up to 50 MHz repetition rate with variable transition times to 5 ns. 50% ±2% ±2 ns to 25 MHz. 50% ±10% ±2 ns for >25 MHz.

Inhibit: Disconnected output and no error checking on channel.

Operational Modes

Continuous: Output continuous at programmed frequency.

Triggered: Output quiescent until triggered for one pulse (or double pulse).

Gated: As triggered mode, except repetition rate generator is enabled for duration of input trigger. Last pulse period started is completed. Maximum gate rate is 25 MHz.

Burst: As triggered mode, except repetition rate generator is enabled for programmed number of pulse periods from 1 to 10,000.

External Width: Trigger duration and rate sets pulse width and repetition rate.

Time Interval: Trigger causes one pulse with programmed width.
Width 20 ns to 9999s.
Resolution: To nearest 20 ns for width <100 μs; to 4 digits for width ≥100 μs.
Accuracy: 2% ±2 ns.
Duty Cycle: 90% limited by 100 ns off time.

PULSE OUTPUTS

Main Output

Upper and lower pulse levels of both main output channels (2nd channel optional) are independently programmable. High impedance or 50Ω source impedance is automatically selected. If upper level, lower level or peak-to-peak amplitude absolute value is >10V, 50Ω internal source is changed to high impedance. The values in table 1 are for a 50Ω load impedance. Pulses of either output channel may be normal or complement. In complement, upper and lower levels are interchanged. Transition times remain as programmed.

Sync Output

A pulse of approximately −0.6 to 3V from 50Ω source at lowest frequency in generator system.

Clock Output

A pulse of approximately −0.6 to 3V from 50Ω source, 50% duty cycle and with programmed repetition rate in continuous, gate and burst modes. Repetition rate in time interval mode determined by microprocessor.

TIME DOMAIN

Repetition Rate

Frequency Range:
0.5 Hz to 50 MHz.
Period Range: 20 ns to 2s.
Resolution: 3 digits of programmed value.
Accuracy: 2% ±1 ns.
Repeatability: 2% ±1 ns.
Jitter: ±0.1% ±50 ps.

Width

Width control affects pulses of the main channels.
Range: 10 ns to 999 ms.
Resolution: 1 ns from 10 ns to 19.999 μs; 3 digits of programmed value from 20 μs to 999 ms.
Accuracy: ±1% ±2 ns.
Repeatability: ±1% ±1 ns.
Jitter:
±0.1% ±50 ps width <1 μs;
±0.05% width 1 to 10 μs;
±0.005% width >10 μs.
Duty Cycle: 90% limited by 10 ns minimum off time.

Delay

Delay control affects pulses of the main channels.
Range: 0 ns to 999 ms.
Resolution: 1 ns from 0 ns to 19.999 μs; 3 digits of programmed value from 20 μs to 999 ms.
Accuracy: ±1% ±2 ns.
Repeatability: ±1% ±1 ns.
Jitter:
±0.1% ±50 ps delay <1 μs;
±0.05% delay 1 to 10 μs;
±0.005% delay >10 μs.
Duty Cycle: 90% limited by 10 ns minimum off time for delay <25 ns and by 20 ns minimum off time for delay ≥25 ns.

Transition Time

For pulses of either main channel, leading and trailing edge transition times independently adjustable from 5 ns to 25 ms (10% to 90% points of programmed amplitude).

Table 1

Characteristics	Hi Impedance Source	50Ω Source
Upper Level Range	−12.00 to +20.00V	−9.96 to +10.0V
Lower Level Range	−20.00 to +12.00V	−10.0 to +9.96V
Resolution (digits of programmed value)	3 digits (20 mV)	3 digits (10 mV)
Amplitude	8.00 to 20.00V	40 mV to 10V
Accuracy	3% program value ±1% ampl ±100 mV	2% program value ±1% ampl ±50 mV
Repeatability	Highly dependent upon cable length and load impedance	±1% ampl ±50 mV
Preshoot		±3% ampl ±10 mV
Overshoot & Ringing		±3% ampl ±10 mV

Range: Variable to 50:1. Leading and trailing edge times must be in the same range.
5 to 100 ns;
50 ns to 2.50 μs;
500 ns to 25 μs;
5 to 250 μs;
50 μs to 2.5 ms;
500 μs to 25 ms.

Resolution: 3 digits of programmed value when both transitions are in the first 10:1 portion of their transition time range, decreasing to 2 digits at 50:1.

Accuracy: ±5% ±2 ns.

Repeatability: ±1% ±1 ns.

Linearity: ±3% for transitions >50 ns.

System Delays
Fixed trigger input to sync output delays for each mode.

Triggered: 60 ± 10 ns;
Gated: 100 ± 10 ns;
Burst: 100 ± 10 ns;
External Width: 40 ± 10 ns;
Time Interval: 80 ± 10 ns.

INPUT CHARACTERISTICS

External Trigger
Arbitrary trigger signals accepted. Rising or falling edge triggering selectable.
Trigger Point: −5 to +5V, adjustable at rear panel.
Impedance: Approximately 1 kΩ paralleled by 22 pf.
Width: 10 ns minimum.
Amplitude: 700 mV minimum.
Repetition Rate:
50 MHz maximum.

Manual Trigger
Front panel key. In gate and external width modes, output active while key depressed.

GPIB Trigger
ASCII "J". In gate and external width modes, "H" signals and of active interval.

GPIB
IEEE 488-1978 compatible for direct connection to GPIB. Optical isolation.
Capabilities:
Listener: AH1 and L4;
Talker: SH1 and T6;
Service Request: SR1;
Remote Local: RL1;
Device Clear: DC1;
Device Trigger: DT1.

Parameter	Typical Programming Time
Command Handshake	2 μs
Data Handshake	220 μs
Frequency	15 ms
Period	20 ms
Upper Level	20 ms
Lower Level	20 ms
Delay	15 ms
Width	18 ms
Leading Edge	35 ms
Trailing Edge	35 ms
Time Interval	10 ms
Mode	10 ms
Function	5 ms
Channel	7 ms
Trigger Format	5 ms
Normal/Complement	5 ms
Output ON/OFF	5 ms
Burst Number	8 ms
Trigger	3 ms
Store Settings	20 ms
Recall Setting	8 ms*
Next Setting	5 ms*
Previous Setting	5 ms*
Execute	20 ms*
GET	2 ms

**2.5 ms when via GET.*

Measurements made with HP9825 controller. Times will vary with different controllers. Data rate will follow slowest listener on bus

GENERAL

Features

Trigger Indicator: Indicates when generator is properly triggered or a burst or time interval is in progress.

Error Detection: Microprocessor detected errors are displayed.

Vernier: Key controlled step or continuous incrementing of any pulse parameter. Cursor selects digit to be updated. Automatic over and under flow.

Nonvolatile Stored Settings: 25 complete front panel setups can be stored and recalled from internal memory. 30 day back-up time.

Reset: Generator is returned to standard setup for confidence check.

Command Recall: Key controlled display of last 36 characters sent via GPIB interface or keyboard.

Return to Local: Key controlled return from GPIB to front panel operation.

Manual Trigger: Key controlled trigger for trigger, gate burst, external width and time interval modes.

Environment
Specifications apply for 25 ± 5°C after 30 minute warm-up. Instrument will operate from 0 to 50°C, 0 to 10,000 feet altitude at 25°C and 0 to 95% relative humidity at 25°C.

Dimensions
Fits standard 48.3 cm (19 in.) rack. Dimensions behind front panel are 43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 58.4 cm (23 in.) deep. Supplied with rack mount adapters.

Weight
26.3 kg (58 lb) net; 30.4 kg (67 lb) shipping.

Power
90 to 105V, 108 to 128V, 198 to 231V or 216 to 252V; 48 to 66 Hz. Single channel, 200 VA. Dual channel, 250 VA.

OPTION

001: Additional Channel
Second channel of delay, width, transition times and output levels. Channels share operating mode and internal clock period only. All other functions and parameters are independent.

010: MATE Interface
Factory installed MATE interface per USAF Standard 2806763.

NOTE: Specifications apply with transition time set to minimum and the 50Ω source driving a 50Ω load.

FACTORY/FOB

San Diego, CA

PRICE

Model 859	**$9950**
Option 001	**$4650**
Option 010	**$4050**

Multi-Channel Brickwall® Filter

- **Frequency Range: 1 Hz to 100 kHz**
- **Rolloff: 115 dB/Octave**
- **Nonvolatile Memory - 16 Settings/Channel**
- **Pre- and Post-Filter Gain**
- **Phase Match: 1°**

Brickwall® Performance
System 716, a multichannel programmable filter system, provides near-ideal passband (0.3 dB p-p) and stopband (115 dB/oct) characteristics in both high pass and low pass filter configurations. Some typical applications include: anti-aliasing for digital signal processing, signal conditioning for separating specified bandwidths of information, and enhancing signal- to-noise ratio.

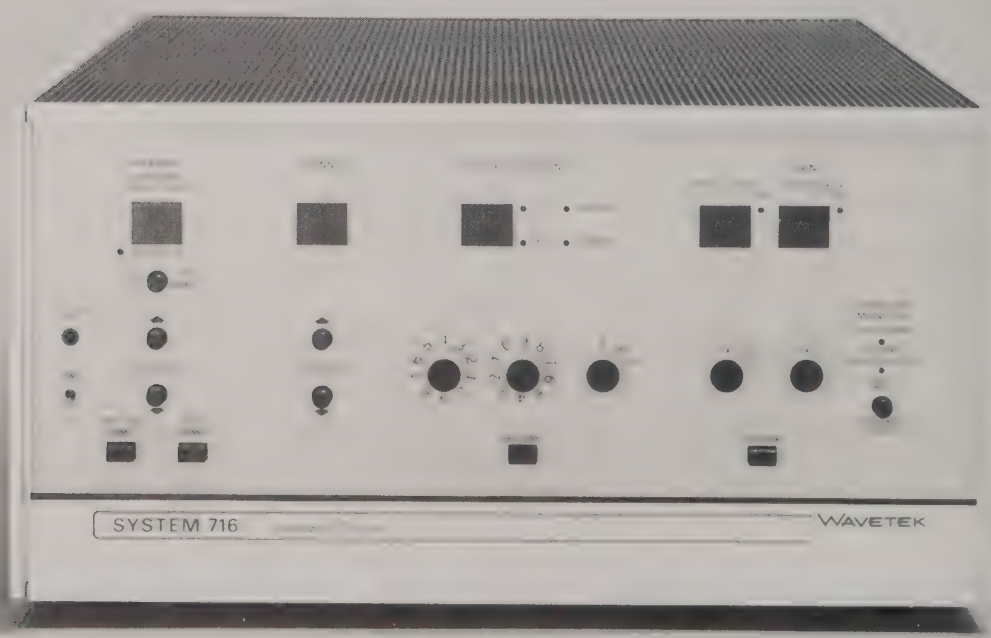
GPIB Programming
An intelligent GPIB interface provides control of all functions including memory, cutoff frequency, gain and overload detection. Self-diagnostics automatically give a check of hardware upon power-up.

Nonvolatile Memory
A RAM (with battery backup) stores up to 16 groups of complete system setups for up to 1000 hours. To restore a programmed setup (gain and cutoff frequency for 16 channels), simply load the desired group number from memory.

Overload Detection
Human engineered overload detection scheme allows monitoring of a single channel or all the channels at once. When all the channels are monitored, an overload is stored and the microprocessor automatically sets the readouts to display the overloaded channel.

Versatility
The patented* System 716 consists of mainframe and a number of plug-in filter cards. The mainframe provides local, on-card, and remote programming, readout facilities, power and input/output connections for up to 16 independent channels. One filter card is required for each channel.

*U.S. Patent 4,246,542



SYSTEM 716 SIGNAL PROCESSING FILTERS

OPTIONS 001 AND 002

FILTER CARDS

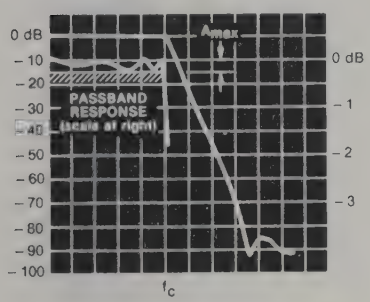
Functions
Low pass (001) or high pass (002); rolloffs of 115 dB/octave.

Cutoff Frequency Range
Local Control: 1 Hz to 99 kHz.
Remote Control: 1 Hz to 100 kHz.

Programming and Resolution
Two 10-position switches and one 4-position multiplier switch.

Multiplier	Frequency	Resolution
×1	1 to 99 Hz	1 Hz
×10	100 to 990 Hz	10 Hz
×100	1k to 9.9 kHz	100 Hz
×1k	10k to 99 kHz	1 kHz

Gain
Pre-Filter Gain: 0, +10, +20, +30, +40 dB (±0.2 dB). One 5-position switch.
Post-Filter Gain: 0, +10, +20 dB (±0.2 dB). One 3-position switch.

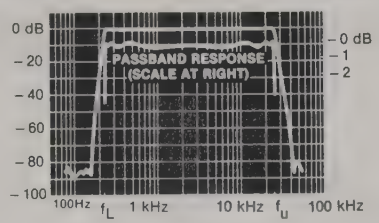


Low-pass Characteristic
High-pass is "Mirror Image".

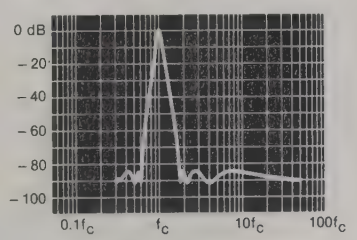
Input Characteristics
Impedance: 1 MΩ, 50 pF, nominal.
Full-Scale Signal: ±10V @ 0 dB gain; divide by gain for other than 0 dB gain settings.
Absolute Maximum Input: ±100V.

Filter Characteristics
Passband Ripple: 0.3 dB, p-p.
Stopband Attenuation: 80 dB, minimum; 85 dB (typical).
f_s/f_c Ratio: 1.7 low pass; 0.6 high pass.

Output Characteristics
Impedance: 50Ω, nominal.
Full-Scale Signal: ±10V into 5 kΩ.
Equivalent Input Noise (at max pre-gain): –150 dBV/√Hz above 50 Hz
Harmonic Components (1 kHz Input Frequency): 80 dB below full-scale
Intermodulation Products (Input frequencies of 70 kHz and 90 kHz): 80 dB below full-scale.
DC Offset: Low pass adjustable to 0 volts. High pass: ±10mV.
Drift (@ 0 dB gain): ±50 mV, 15°C to 40°C.



Normal Bandpass f_U/f_L = 100.



Minimal Bandpass
(Note Freedom from "Tenting" Loss.)

Crosstalk Between Channels (Input Source 50Ω or less):
RT0**: 85 dB below full scale.
RTI*: 110 dB below full scale.
Line Related or Spurious Components (Input Source 50Ω or less):
90 dB below full-scale.

Phase Match Between Channels
Low Pass: ±½° typical, ±1° max (DC to 0.8 f_c); ±1° typical, ±2° max (0.8 f_c to f_c).
High Pass: ±½° typical, ±1° max (1.3 f_c to 100 kHz); ±1° typical, ±2° max (f_c to 1.3 f_c).

Amplitude Match Between Channels
Low Pass: ±0.1 dB (DC to 0.8 f_c); ±0.2 dB (0.8 f_c to f_c).
High Pass: ±0.1 dB (1.3 f_c to 100 kHz); ±0.2 dB (f_c to 1.3 f_c).

MODEL 716-11 MAINFRAME

Memory
Sixteen selectable groups; each group has storage for 16 channel settings.

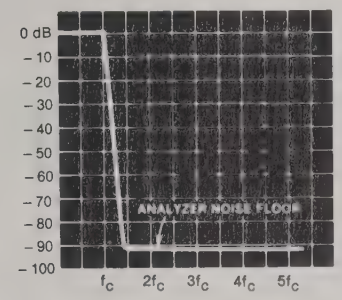
Battery Back-Up For Memory
Trickle charged, when unit is powered; 1000 hours nominal back-up and an LED low battery indicator

Display
Seven-segment displays for
Group Number
Channel Number
Pre-Filter Gain
Post-Filter Gain
Cutoff Frequency

Channel Characteristic
LED for high pass or low pass

Overload Indicators
Two LED's, one for filter input and one for filter output. Two overload modes can be selected: one mode monitors input and output of selected channels; the other mode monitors all channels and indicates which one is overloading.

Remote Programming/Sensing
IEEE 488-1978 (GPIB) digital interface meets the following standards: SH1, AH1, T6, TE0, L3, LE0, SR1, AL2, PP1, DC0, DT0, C0, E1.



Two LP Channels Cascaded

Self-Test Diagnostics
Microprocessor checks unit on power up; failure mode indicated on 7-segment displays.

Input/Output Connectors
BNC's on rear panel.

GENERAL

Environment
Operating Temperature: 0°C to 40°C.
Storage Temperature: –20°C to +50°C.

Dimensions
43.2 cm (17 in.) wide; 22.2 cm (8¾ in.) high; 53.4 cm (21 in.) deep.

Weight
Mainframe: 15.4 kg (34 lb) net; 26.8 kg (59 lb) shipping.
Filter Card: 0.5 kg (1.2 lb) net; 1 kg (2.2 lb) shipping

Power
115/230V ±10%, 48 to 400 Hz, 150 watts (less than 7 watts/channel)

*Referenced to Input
**Referenced to Output

FACTORY/FOB

San Diego, CA

PRICE

Model 716-11	**$3995**
Option 001	**$1450**
Option 002	**$1450**

Programmable Multi-Channel Analog Filter

- **Frequency Range: 0.1 Hz to 150 kHz**
- **Up to 16 Independent Channels In 5¼ in. Panel**
- **Rolloff: 48 dB/Octave**
- **Responses: Butterworth and Bessel**
- **Dynamic Range: 80 dB**
- **Local, Remote, and On-Card Programming**

Design
System 816 is a versatile, fully programmable, multi-channel filter system capable of processing up to 16 independent analog signal channels. Two 48 dB/octave responses are available: an 8-pole Butterworth and an 8-pole Bessel. The Butterworth low-pass configuration may be altered to high-pass, and thus, by combining two channels, bandpass and band-reject filters may also be realized.

Applications
Among its many applications, System 816 is widely used in spectrum analysis for band-limiting analog signals prior to sampling and analog-to-digital conversion to prevent the "aliasing" of out-of-band components into the frequency band of interest. In this application, as the sampling frequency is changed, the cutoff frequency of the filters is automatically programmed to a corresponding value typically less than half the sampling frequency, to obtain optimum out-of-band signal rejection.

System 816 is ideally suited to automated data acquisition and signal processing in such fields as sonar, vibration, speech, medicine, geophysics and process control.

Versatility
System 816 consists of mainframe and a number of plug-in filter cards. The mainframe provides local, on-card, and remote programming, read-out facilities, power and input/output connections for up to 16 independent channels. One filter card is required for each channel. The user may thus purchase the mainframe and as many filter cards as initially required. System 816 may then be expanded in the future by only purchasing additional filter cards.

SYSTEM 816 SIGNAL PROCESSING FILTERS

FUNCTIONS

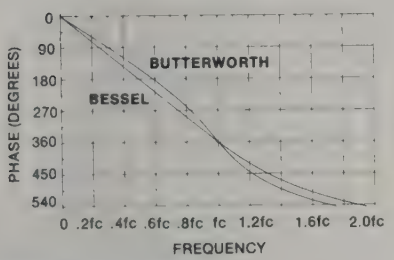
Butterworth: Low pass and high pass that may be combined for band pass and band reject filters.
Bessel: Low pass only.
Rolloff: 48 dB/octave/channel.

Cutoff Frequency
Accuracy: ±2% (±3% on highest multiplier).
Resolution: 15 different values (1 to 15) for each of 4 multiplier ranges:

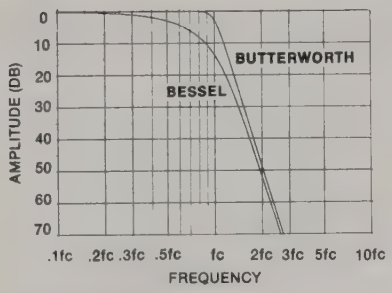
Option Sets (See Cutoff Freq. Range Options table below)	Multiplier
11, 001, 005	×10, ×100, ×1K, ×10K
12, 002, 006	×1, ×10, ×100, ×1K
13, 003, 007	×0.1, ×1, ×10, ×100

Filter Card Compatibility
Mainframes differ only in front panel marking of multiplier ranges. Mixing in a common mainframe of Butterworth, Bessel, and/or Filter Cards having different frequency ranges is permissible provided:

1. Notation of card type and channel address is made in the software when in REMOTE mode.
2. User is otherwise made aware of card type and channel address when in LOCAL mode.



Typical Phase Response



Typical Amplitude Response

Filter Bypass
Obtained by selecting no MULTIPLIER range and a UNITS value of 15. In this configuration, the filter operates as a DC amplifier with unity gain. Either low pass Butterworth or Bessel cards may be used in the bypass mode.

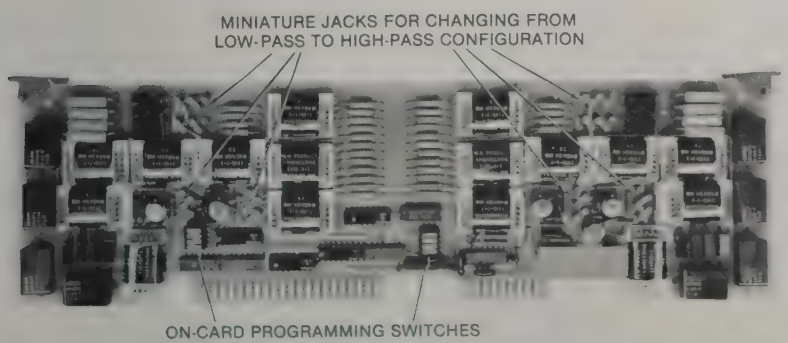
Gain
0 dB ±0.25 dB.

Input Characteristics
Circuit: single-ended; DC isolated from power ground.
Impedance: 1 MΩ shunted by 50 pF.
Full Scale Signal: ±10 Vp-p.
Absolute Max Input: ±100V.

Output Characteristics
Circuit: Single ended, DC isolated from power ground.
Impedance: 50Ω.
Full Scale Signal: ±10V, ±20 mA into 50Ω (typical).
Noise and AC line related spurs (100 kHz detector bandwidth): 80 dB below full-scale (input shorted).
Distortion: <0.1%.
DC Offset: 0 ±10 mV.
Drift: 0.5 mV/°C (typical).

CUTOFF FREQUENCY RANGE OPTIONS

Mainframe	Filter Cards: Butterworth (LP, HP)	Filter Cards: Bessel (LP only)	Overall Frequency Range
11	001	005	10 Hz to 150 kHz
12	002	006	1 Hz to 15 kHz
13	003	007	0.1 Hz to 1.5 kHz

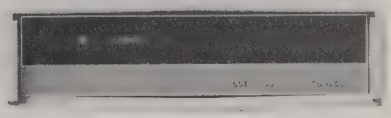


Filter Card Assembly — Butterworth

Phase Match between Channels
±2° or ±2%, whichever is greater.

PROGRAMMING/SENSING

Standard
Front panel toggle switches, on-card programming and 17 remote TTL compatible lines.
Programming Delay: <3 ms for any function.



Model 1488A

Optional GPIB
The Model 1488A-13 provides the following IEEE 488-1978 functions: AH1, L1 (listen only), DT1. It contains special logic for programming sequential (NORMAL) and simultaneous (COMMON) modes as well as PRESET mode.

GENERAL

Accessories Supplied
Three mating connectors and operating manual.

Environment
Operating Temperature: 0°C to +50°C.
Storage Temperature: −20°C to +70°C.

Dimensions
Mainframe: 48.3 cm (19 in.) wide; 13.3 cm (5¼ in.) high; 48.3 cm (19 in.) deep.

Weight
Mainframe: 10.9 kg (24 lb) net; 14.6 kg (32 lb) shipping.
Filter Card: 0.5 kg (1 lb) net; 1 kg (2 lb) shipping.

Power
115/230V ±10%, 50 to 60 Hz, 200 watts, max. (less than 13 watts per channel).

FACTORY/FOB

San Diego, CA

PRICE

Model 816-11, 12 or 13 Mainframe	**$2250**
Option 001, 002, or 006 Filter Card	**$1050**
Option 003 or 005 Filter Card	**$1100**
Option 007 Filter Card	**$1175**
Model 1488-13	**$925**

Programmable Brickwall® Filters

- **Frequency Range: 1 Hz to 100 kHz**
- **Rolloff: 115 dB/Octave**
- **Resolution: 2 Digits**
- **Overload Detectors**
- **Options: GPIB and BCD Interfaces**

Design
Models 751A, 752A and 753A are wide-range tunable, programmable Brickwall® filters with near ideal passband and stopband characteristics.

Each network or channel employs a patented *7th order elliptic (Cauer) filter with very high attenuation slopes of 115dB/octave.

Filtering
The slope or rolloff rate of any filter is the measure of how cleanly it discriminates between frequencies that should be passed and those that should be removed through attenuation.

The slope of the 750 series comes close to the infinitely steep slope of the ideal (but unrealizeable) filter. It keeps out unwanted frequencies like a Brickwall® .

Features
Programming of high and low filter cutoff frequencies, pre-filter gain, and post-filter gain is by front panel controls and optionally, by digital programming through a BCD parallel-input, buffered interface or an IEEE 488-1978 (GPIB) bus interface.

Model 751A Bandpass Filter
Model 751A offers a single channel of bandpass filtering with independent control of high pass and low pass sections and up to 40dB of prefilter gain and 20dB of post-filter gain.

Model 752A Dual Low Pass Filter
Model 752A is a dual-channel low pass unit. The channels are identical, and usable independently, or in series. In cascade, the two channels offer the exceptionally high rolloff of 230dB/octave.

Model 753A High Pass/Low Pass Filter
Model 753A provides independent high pass and low pass channels. Each channel permits up to 40dB of prefilter gain.

*U.S. Patent 4,246,542

MODELS 751A, 752A & 753A SIGNAL PROCESSING FILTERS

FUNCTIONS

Model 751A: Bandpass with independent control of high pass and low pass sections.
Model 752A: Dual indepenent low pass channels.
Model 753A: Independent high pass and low pass channels.

CUTOFF FREQUENCY (f_c)

Range
1 Hz to 99 kHz with front panel control and GPIB.
1 Hz to 100 kHz with remote control (BCD only).

Control (Each Channel)
Two 10-position switches, one 4-position multiplier switch; remotely by 12-bit code.

Resolution Multiplier	Frequency (Local)	Resolution
X1	1 to 99 Hz	1 Hz
X10	100 to 990 Hz	10 Hz
X100	1k to 9.9 kHz	100 Hz
X1k	10k to 99 kHz	1 kHz

Accuracy
-0.3 ± 0.1 dB at f_c

Stability
± 200 ppm/°C

Gain (Prefilter)
0 to +40 dB (± 0.2 dB) in 10 dB steps. One 5-position switch or 3-bit code.

Gain (Postfilter)
(Model 751A only.) 0, +10, +20 dB (± 0.2 dB). One 3-position switch, or 2-bit code.

INPUT CHARACTERISTICS

Coupling
Low Pass channel: DC, AC with 0.3 Hz nominal cutoff.
High Pass channel: DC.
Impedance: 1 MΩ, 50 pF, nominal.

Full-Scale Signal
± 10V at 0 dB gain; ± 100V absolute max.

Equivalent Input Noise
-150 dBV/$\sqrt{}$Hz with +40 dB gain.

OUTPUT CHARACTERISTICS

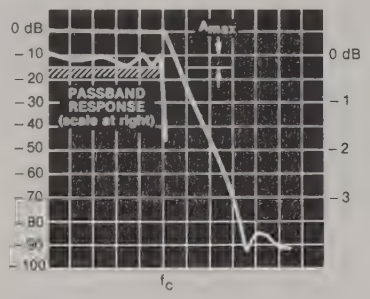
Impedance
50Ω nominal.

Full-Scale Signal
± 10V, into 5 kΩ.

Noise (1 MHz BW)
>80 dB below full-scale referred to output at any prefilter gain. (0 dB post filter gain (Model 751A only).
<10 μV referred to input at 40 dB prefilter gain.

Harmonic Components
>80 dB below full-scale for 1 kHz input frequency.

Spurious Components
>80 dB below full-scale (includes line related spurious).

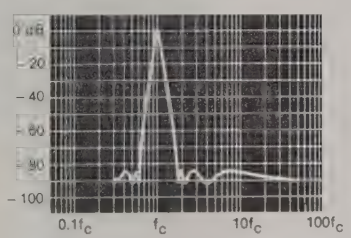


Low-pass Characteristics (Pass-band Response Detail) High-pass Is "Mirror Image".

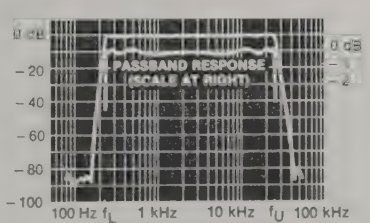
Intermodulation Products
>70 dB below full-scale for 90 kHz and 70 kHz input frequencies.

DC Offset
Adjustable to 0V. Adjustable to ± 10 mV (High Pass Filter Model 753A).

Drift
± 50 mV max, 0°C to +40°C at 0 dB gain setting.



Minimal Bandpass Characteristic (Both Sections Set to Same f_c)



Normal (or Narrow) Bandpass Characteristic.

FILTER CHARACTERISTICS

Type
7-pole, 6-zero elliptic (Cauer)

Rolloff
115 dB/octave

Passband Response
Low Pass channel: 0.3 dB, p-p
High Pass channel: 0.3 dB, p-p
(−3 dB at approx. 400 kHz)

Stopband Attenuation
Low Pass channel:
−0.3 dB (DC to f_c),
−40 dB at 1.34 f_c,
−60 dB at 1.53 f_c.
−85 dB at 1.7 f_c
High Pass channel:
−0.3 dB at f_c,
−40 dB at 0.75 f_c,
−60 dB at 0.65 f_c.
−85 dB at 0.6 f_c.

Maximum Stopband Attenuation
Low Pass channel: 85 dB typ; 80 dB min. to 10 MHz.
High Pass channel: 85 dB typ; 80 dB min.

Amplitude Match
(Model 752A only.)
± 0.1 dB, DC to 0.8 f_c,
± 0.2 dB, 0.8 f_c to f_c.

Phase Match
(Model 752A only.) $\pm 1/2°$ typ, $\pm 1°$ max, DC to 0.8 f_c.

GENERAL

Accessories Supplied
Operating manual and rack mounting kit.

Input/Output Connections
BNC's on front and rear panel

Environment
Operating Temperature: 0°C to +40°C.
Storage Temperature: −20°C to +70°C.

Dimensions
43.2 cm (17 in.) wide, 8.9 cm (3½ in.) high, 33 cm (13 in.) deep

Weight
8.2 kg (18 lb) net, 10.5 kg (23 lb) shipping.

Power
115/230V ±10%. 50 to 60 Hz 25 watts.

OPTIONS

001: BCD Interface
A total of 35 bits (lines) for programming are provided.
Programming delay is 500 μs plus filter settling time, which is a function of cutoff frequency being programming

002: IEEE 488-1978 Bus Interface (GPIB)
Provides the following IEEE functions
AH1 (Acceptor Handshake),
L1 (Basic Listener with Listen only),
DT1 (Device Trigger).

FACTORY/FOB

San Diego, CA

PRICE

Model 751A	**$3950**
Model 752A	**$4300**
Model 753A	**$4350**
Option 001	**$750**
Option 002	**$825**

Dual HI/LO Variable Analog Filters

- **Frequency Range: 0.01 Hz to 111 kHz**
- **Resolution: 3 Digits**
- **Cutoff Frequency Accuracy: ± 2%**
- **Responses: Butterworth and Flat Delay**
- **Dynamic Range: 90 dB**
- **Low Noise**

Design
The Models 452 and 852 Dual HI/LO Filters each consist of two identical filter channels contained in a common cabinet. Each filter channel has separate input/output terminals, offers high pass and low pass functions, 0 dB and 20 dB gain, Butterworth/Flat Delay responses and 3-digit resolution for cutoff frequency selection.

Versatility
Individual channels may be readily interconnected for series or parallel operation, resulting in bandpass (or doubled rolloff) and band reject functions respectively.

Each filter channel provides switch selectable Flat Amplitude (Butterworth) response for frequency domain applications and Flat Delay response for transient-free time domain applications.

The Models 452 and 852 are electrically and mechanically similar, each covering the cutoff frequency range of 0.1 Hz to 111 kHz. Rolloff of the Model 452 is 24 dB/octave/channel, while the Model 852 is 48 dB/octave/channel. The factory installed Option 001 will extend the cutoff frequency range and resolution on the Models 452 and 852 to 0.01 Hz.

Implementation
Frequency determining passive elements of the filters are stable precision metal film resistors and close tolerance polycarbonate or mica film capacitors. The active elements are FET-input IC operational amplifiers which provide highly stable gain, and very low noise and distortion. This combination of active and passive elements produces a filter having high cutoff frequency accuracy and resettability, excellent temperature stability and long term stability. Another result of precise control of frequency-determining elements is close amplitude and phase match between channels.

MODELS 452 & 852 SIGNAL PROCESSING FILTERS

FUNCTIONS

Low Pass, High Pass, Band Pass, Band Reject, Notch.

Frequency Range and Resolution

Three 11-position switches and one 4-position multiplier (option 001 adds fifth position to multiplier).

Multiplier	Frequency (Hz)	Resolution (Hz)
×1*	0.01 to 11.1	0.01
×10	0.1 to 111	0.1
×100	1 to 1.11k	1
×1k	10 to 11.1k	10
×10k	100 to 111k	100

*Option 001 only

Attenuation Rate per Channel

452/452-001: 24 dB/octave.
852/852-001: 48 dB/octave.

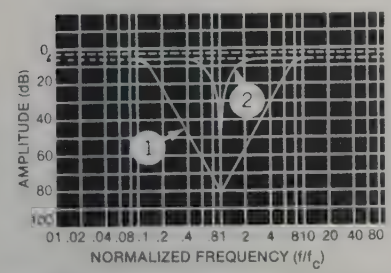
FLAT AMPLITUDE (BUTTERWORTH) RESPONSE

Passband Gain (452/452-001)

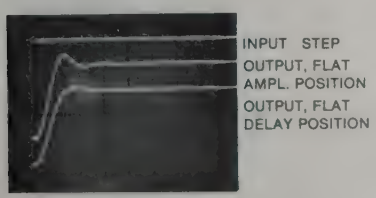
Low Pass: 0 dB/20 dB, ±0.25 dB.
High Pass: 0 dB/20 dB, ±0.25 dB. (±0.5 dB in ×10k Multiplier position); −3 dB at approx. 2 MHz.

Passband Gain (852/852-001)

Low Pass: 0 dB/20 dB, ±0.5 dB.
High Pass: 0 dB/20 dB, ±0.5 dB (±1 dB in ×10k Multiplier position): −3 dB at approx. 1 MHz.



Band Reject (1) and Sharp Notch (2) Obtained by Parallel Connection of 24 dB/Octave Filter Channels



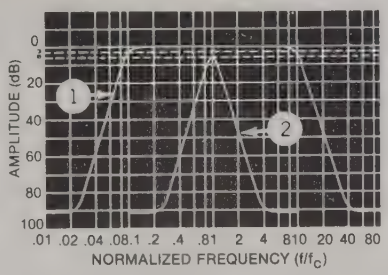
Transient Response - Low Pass Mode (Model 452/452-001 only)

Attenuation at Cutoff

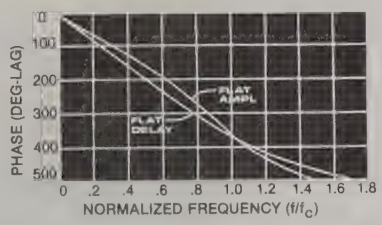
3 dB.

Maximum Stopband Attenuation

90 dB.



Band Pass (1) with LP = 0.01 HP and Minimum Bandwidth Band Pass (2) with LP = HP Obtained by Series Connection of 48/Octave Filter Channels.



Phase Characteristics - Low Pass Mode (Model 852/852-001 only)

Phase Match Between Channels (Typical)

452/452-001: 1° or 1%, whichever is greater.
852/852-001: 2° or 2%, whichever is greater.

FLAT DELAY RESPONSE

Low Pass Delay (Typical)

452/452-001: $1/(2f_c)$ seconds.
852/852-001: $1/f_c$ seconds.

Attenuation Cutoff

452/452-001: Approx 9 dB.
852/852-001: Approx 17 dB.

INPUT CHARACTERISTICS

Circuit

Single-ended, diode protected.

Impedance

1 MΩ shunted to 50 pF; 75 pF in 20 dB gain (852/852-001).

Full-Scale Signal at 0 dB Gain

±10V (7.1 Vrms), DC to 300 kHz, decreasing to ±4V (2.8 Vrms) at 1 MHz (divide these by 10 at 20 dB gain).

Absolute Max Input

±100 V.

Max. DC Component (High Pass)

±100V, 0 dB gain.
±10V, 20 dB gain.

OUTPUT CHARACTERISTICS

Circuits

Single-ended. Short-circuit protected may be DC isolated from power ground by rear panel switch.

Impedance

50Ω.

Full-Scale Signal

±10V (7.1 Vrms), DC to 300 kHz, decreasing to ±4V (2.8 Vrms) at 1 MHz ($R_L \geq 5$ kΩ), ±15 mA max. current.

Broadband Noise at Either Gain Setting (100 kHz detector bandwidth)

452/452-001: 100 μVrms.
852/852-001: 200 μVrms.

Harmonic Components

Input f = 1 kHz
452/452-001: 90 dB below full-scale.
852/852-001: 80 dB below full-scale.

AC Line-Related Spurious Components

452/452-001: 110 dB below full scale.
852/852-001: 100 dB below full scale.

DC Offset at 25°C

452/452-001: 0 ±2.5 mV DC.
852/852-001: 0 ±2.5 mV DC.

GENERAL

Environment

Operating Temperature: 0°C to +50°C.
Storage Temperature: −20°C to +70°C.

Dimensions

43.2 cm (17 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.

Weight

Model 452: 4.5 kg (10 lb) net. 6.4 kg (14 lb) shipping.
Model 852: 5.5 kg (12 lb) net. 6.8 kg (15 lb) shipping.

Power

115/230V ±10%, 50 to 500 Hz, 5 watts.

OPTIONS

001: Range Extension

Extends low frequency range and resolution to 0.01 Hz; performance specifications remain the same, except AC line-related spurious components degraded by 6 dB when operating in the optional range. Factory installed.

002: 600Ω Output Impedance.

004: Rack-Mount Kit

Field installable.

FACTORY/FOB

San Diego, CA

PRICE

Model 452	**$2050**
Model 852	**$2650**
Option 001 (For 452) Original order only	**$300**
Option 001 (For 852) Original order only	**$575**
Option 002	**$75**
Option 004	**$35**

Dual HI/LO Variable Analog Filters

- **Frequency Range: 1 Hz to 1.1 MHz**
- **Resolution: 2 Digits**
- **Cutoff Frequency Accuracy: ±5%**
- **Responses: Butterworth and Flat Delay**
- **Rolloff: 24 dB/Octave/Channel**
- **Low Noise**

Design
Models 432 and 442 Dual HI/LO Filters each consist of two identical filter channels contained in a common cabinet. They feature digital tuning performance at prices very competitive with older-style continuously tuned filters. Backlash, parallax and other resettability problems inherent in continuously tuned filters are eliminated by the digital cutoff frequency selection of the Models 432 and 442.

Each filter channel has separate input/output terminals, offers high pass and low pass functions, 0 dB and 20 dB gain, Butterworth and Flat Delay response and 2-digit resolution for cutoff frequency selection.

Versatility
Individual channels may be readily interconnected for series or parallel operation, resulting in bandpass (or double rolloff) and band reject (including notch) functions, respectively.

Each filter channel provides switch selectable Flat Amplitude (Butterworth) response for frequency domain applications and Flat Delay response for transient-free time domain applications.

Range
Model 432 covers the cutoff frequency range of 1 Hz to 110 kHz; Model 442 covers 10 Hz to 1.1 MHz. Rolloffs are 24 dB/octave/channel.

Implementation
Frequency determining passive elements of the filters are stable precision metal film resistors and close tolerance capacitors. Active elements are IC operational amplifiers which provide stable gain with very low noise and distortion. This combination of elements produces a filter with high cutoff frequency accuracy and excellent temperature and long term stability.

FUNCTIONS

Low pass, high pass, band pass, band reject, notch.

Frequency Range and Resolution
2 digit resolution as follows:

Multiplier	Frequency (Hz)	Resolution (Hz)
×1(432)	1 to 110	1
×10	10 to 1.1k	10
×100	100 to 11k	100
×1k	1k to 110k	1k
×10k(442)	10k to 1.1M	10k

Attenuation Rate (Rolloff) per Channel
24 dB/octave.

RESPONSE

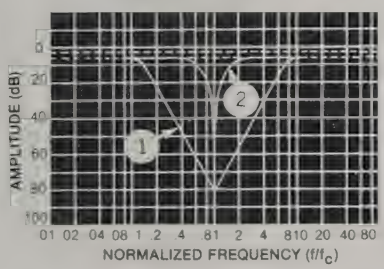
Flat Amplitude (Butterworth)
Passband Gain, Low Pass: 0 dB/20 dB, ±0.5 dB.
Passband Gain, High Pass: 0 dB/20 dB, ±0.5 dB.
(±1 dB in highest multiplier position); approximately 3 dB down at f≥2x maximum f_c.
Attenuation at Cutoff: 3 dB.
Maximum Stopband Attenuation
80 dB (Input f≤1 MHz).
Flat Delay
Low Pass Delay (Typical):
$1/(2f_c)$ sec.
Attenuation at Cutoff: Approx. 9 dB.

INPUT CHARACTERISTICS

Circuit
Single-ended, diode-protected.
Impedance
Model 432: 1 MΩ in parallel with 50 pF.
Model 442: 100 kΩ in parallel with 50 pF.
Full-Scale Signal at 0 dB Gain
Model 432: ±7V (5 Vrms) DC to 100 kHz. ±0.7 (0.5 Vrms) at 20 dB gain.
Model 442: ±7V (5 Vrms) DC to 1 MHz. ±0.7 (0.5 Vrms) at 20 dB gain.
Absolute Maximum Input
±100V.
Maximum DC Component
High Pass: ±100V, 0 dB Gain, ±10V, 20 dB Gain.

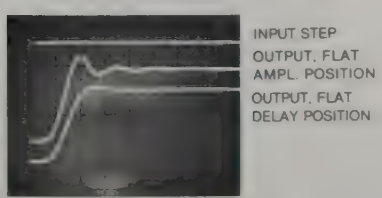
OUTPUT CHARACTERISTICS

Circuit
Single-ended, short-circuit protected; may be DC isolated from power ground by rear panel switch.
Impedance
50Ω.
Full-Scale Signal
Model 432: ±7V (5 Vrms) DC to 100 kHz, decreasing at higher frequencies. R_L≥5 kΩ, ±15 mA maximum current.
Model 442: ±7V (5 Vrms) DC to 1 MHz, decreasing at higher frequencies. R_L ≥5kΩ, ±15 mA maximum current.
Broadband Noise at Either Gain Setting
Model 432: 250 μVrms maximum for 100 kHz detector bandwidth.
Model 442: 500 μVrms maximum for 1 MHz detector bandwidth.

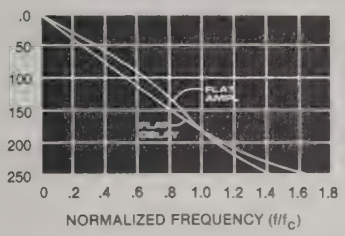


Butterworth (Flat Amplitude) Response Showing Band Reject (1) and Sharp Notch (2). Obtained by Parallel Connection of 2 Individual 24 dB/oct Filter Channels.

DC Offset at 25°C
Model 432: 0 ± 1 mV dc.
Model 442: 0 ± 50 mV dc.
Harmonic Components
Model 432: 80 dB below full-scale signal, (Input f = 1 kHz).
Model 442: 70 dB below full-scale signal, (Input f = 10 kHz).



Transient Response - Low Pass Mode



Phase Characteristics - Low Pass Mode

AC Line-Related Spurious Components
100 dB below full scale.
Drift vs Temperature
1 mV/°C.

GENERAL

Environment
Operating Temperature: 0°C to +50°C.
Storage Temperature: −20°C to +70°C.
Dimensions
43.2 cm (17 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.
Weight
4.5 kg (10 lb) net; 6.5 kg (14 lb) shipping.
Power
115/230V ±10%, 50 to 500 Hz, 5 watts.

OPTIONS

002: 600Ω Impedance
Model 432 only.
004: Rack Ears

FACTORY/FOB

San Diego, CA

PRICE

Model 432	**$1650**
Model 442	**$1825**
Option 002	**$75**
Option 004	**$35**

Audio Output Impedance Adapter

- **Isolated Floating Output**
- **Selectable Output Impedance**

Model 16 immediately adapts your function generator for use with audio devices that have the popular 150 ohm and 600 ohm impedances.

Model 16 converts the 50 ohm output of a function generator or other audio signal source to a transformer coupled, floating output with a switch selectable impedance of either 150 or 600 ohms. The adapter connects directly to the BNC output connector of the signal source.

The Model 16 output is a floating female BNC connector which may be converted to dual binding posts or banana jacks with the included accessory connector.

SPECIFICATIONS

Sinewave Frequency Response: 25 Hz to 25 kHz, ± 3 dB at 1.0 mW.

Typical Output Power: 1 kHz sine wave from signal source of 50 ± 1Ω output impedance, ≤15 Vp-p terminated, delivers ≤30 mW into 600 or 150Ω load.

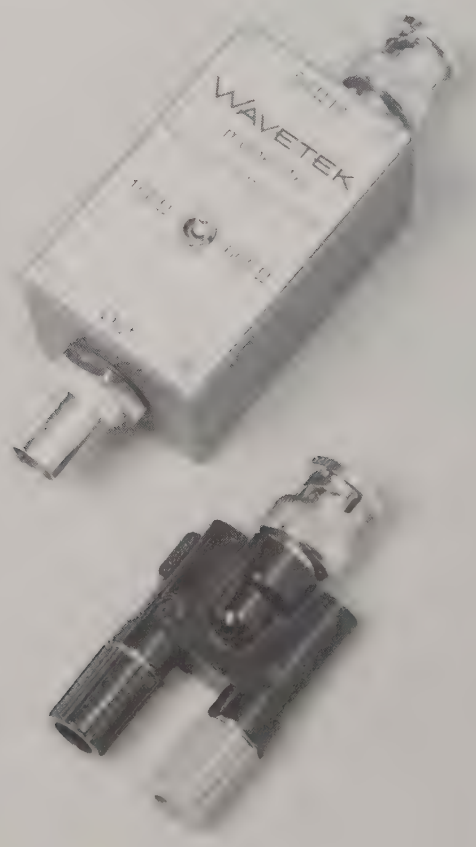
Typical Harmonic Distortion: <1.0% THD, 200 Hz to 25 kHz. <5.0% THD, 25 to 200 Hz at 1 mW.

FACTORY/FOB

San Diego, CA

PRICE

Model 16 **$175**



SYNTHESIZER SELECTION GUIDE

Top Frequency	2 MHz	3 MHz		50 MHz	160 MHz			430.1 MHz	1000 MHz
MODEL	650	5100	5101	178	5120A	5130A	5135A	System 36	5155A
Low Frequency	100μHz	DC	1 Hz	100μHz	100 kHz				
Frequency Resolution	10 digits or 0.1 mHz	0.001 Hz	1 Hz	8 digits	0.1 Hz	0.1 Hz (Local) 0.001 Hz (Remote)			0.1 Hz
Switching Transient	⩽500 ns	<600 ns		N/A	20 μs	3-20 μs	1-10 μs	3-20 μs	100 ns to 100 μs
Phase Continuous Switching	•	•	•	N/A	*	*	*	*	*
Phase Control	•			•					
Output Level	50 Vp-p	1 Vrms 10 Vp-p (2 MHz)	1 Vrms**	20 Vp-p	+3 to +13 dBm				
Frequency Response	±0.5% (<100 kHz) ±3% (⩽2 MHz)	±0.25 dB (<500 kHz) ±0.5 dB (<3 MHz)		±1% (1μHz – 20 kHz) ±15% (to 50 MHz)	±0.5 dB				±0.5 dB (1 – 500 MHz) ±1.0 dB (⩾500 MHz)
Spectral Purity Spurious	– 70 to – 50 dBc	– 70 dBc (<100 kHz) – 60 dBc (<500 kHz) – 50 dBc (<2 MHz)			– 70 dBc				– 70 dBc (<500 MHz) – 64 dBc (⩾500 MHz)
Harmonics	– 40 to – 60 dBc	– 40 to – 55 dBc		– 30 to – 55 dBc	– 35 dBc				– 20 dBc (>1 MHz)
SSB Phase Noise (Residual) 100 Hz					– 100 dBc/Hz				– 100 dBc/Hz (<500 MHz)
10 kHz					– 120 dBc/Hz				– 120 dBc/Hz
100 kHz					– 125 dBc/Hz				– 125 dBc/Hz
Integrated Phase Noise (30 kHz BW)††	– 50 dBc (<2 MHz)			<46 dBc	– 70 dBc				– 70 dBc (<500 MHz) – 64 dBc (2500 MHz)
Internal Ref Standard	10 MHz	8 MHz	N/A	10 MHz	10 MHz (Option)				
External Ref Standard	10 MHz	1,8 MHz 5,10 MHz Option)	8 MHz	1 to 10 MHz	5, 10 MHz (1 MHz Option)				
Trigger/Gate/Burst/ Sweep Modes	•			•					
Multi-Channel	•								
Triangle/Ramp/Square	•			•					
Local Control	•	•		•	•	•	•	•	•
Remote Control (TTL)		•†	•		•†	•†	•†	•	•†
GPIB Programmable	•	Option		•	Option				
Featured on Catalog Page	12	94	***	68	96	96	96	***	98

*Over limited frequency range
**Other fixed levels available
***Consult factory for more details

†Remote only units available. See detailed specifications
††Excludes 1 Hz centered about fundamental frequency

RF SWEEP GENERATOR SELECTION GUIDE

Top Frequency (Low Frequency is 1 MHz)	400 MHz		500 MHz	1000 MHz		1400 MHz	2500 MHz	4500 MHz
MODEL	1062	1067	1067-522	1080, 1081	1801C	2001	2002B	2005
Output Power (dBm)	+10 to −55	+57 to −7 (dBmV)		+13 to −70 (1080) +60 to −10 dBmV (1081)	+57 to −33 (dBmV)	+10 to −80	+13 to −77	+13 to −57
Flatness (dB)	±0.25	±0.5		±0.25		±0.5		±0.75
Spurious Content Harmonic	>30 dBc above 10 MHz			>30 dBc above 20 MHz	>30 dBc above 10 MHz			*
Frequency Bands	1 Band					*	*	*
Impedance	50Ω	75Ω (50Ω 1080)			75Ω**	50Ω		
Sweep Time	Variable/Line Locked				Variable/Line Locked/Calibrated Manual			
Operating Modes	ΔF/CW			Full Sweep/ ΔF/CW	ΔF/CW	Start Stop/ΔF/CW		
Modulation Capability	AM/FM			FM Only	AM/FM			
Remote Programming: Analog Standard for Center Frequency, Sweep Width and Output Level	•	•		•	•	• GPIB Optional*		
Square Wave Generator							•	•
Marker System	Optional			•	Optional		•	•
Featured on Catalog Page	100	100	100	102	104	106	138	138

*See specifictions
**50Ω available

RF SIGNAL GENERATOR SELECTION GUIDE

Top Frequency	520 MHz			1040 MHz	2080 MHz
MODELS	3000	3006	3007	3510B	3520
Low Frequency	1 MHz	1 kHz		1 MHz	
Frequency Resolution	1 kHz (6 digits)	100 Hz (7 digits)	1 kHz (6 digits)	100 Hz (7 digits)	
RF Output	+13 to −137 dBm				+10 to −137 dBm
AM/CW Frequency Accuracy	±0.001% (±0.0002% typical)				
FM Frequency Accuracy	*	±0.01% (±0.002% typical)			
Flatness	+13 to −7 dBm: ±0.75 dB (±0.5 dB typical)			+13 to −6.9 dBm: ±1 dB	+10 to −6.9 dBm: ±1.5 dB
Modulation Modes	AM/FM	Complex AM/FM	AM/FM	Complex AM/FM	
Modulation Frequencies Internal (AM and FM)	400 Hz, 1 kHz	**	400 Hz, 1 kHz	Programmable 80 Hz to 10 kHz	
External AM	DC to 20 kHz			30 kHz	
External FM	DC to 25 kHz			60 kHz	
Modulation Scales	1 AM, 2 FM	2 AM	1 AM, 2 FM		
Modulation Indicator	Calibrated Slide	Meter	Calibrated Slide	Display	
Vernier Controls	Output Level Only	Frequency and Output Level		Cursor	
Frequency Programming	BCD			GPIB	
RF Level (BCD) Programming (0.1 dB Steps)				GPIB	
Options (Not all options are available on all models. For model/option availability, see page 124	External Pulse Modulation (02A), External Reference (05), External Reference/High Stability (05A), High Stability Reference (06), Low Frequency Extension to 1 kHz (08).				
Featured on Catalog Page	114	116	118	120	122

*See specifications.

**Four: 400 Hz, 1000 Hz and two user selected frequencies in the range of 100 Hz to 10 kHz.

Programmable Frequency Synthesizers

- **Frequency Range: DC to 3 MHz**
- **Resolution: Constant 0.001 Hz**
- **Direct Digital Synthesis: No Range Multipliers, Mixing or Phase Lock Loops**
- **Ultra-Fast Switching: 1.5 μs**
- **True Phase and Amplitude Continuity**

Versatility
Models 5100 and 5110 Programmable Frequency Synthesizers provide spectrally pure output frequencies in 0.001 Hz steps from DC to 3 MHz. Model 5100 may be programmed locally and remotely; Model 5110 is intended for remote-only applications.

Synthesis Technique
A patented* direct digital synthesis technique is used to generate the output frequency directly from an internal crystal reference, which may be phase locked to an external 1 MHz standard, if desired.

Design
In addition to excellent short term stability, digital synthesis also provides other improvements in performance. Digital operation means inherent programmability and very fast switching. In binary word format, Models 5100 and 5110 synthesizers maintain *amplitude and phase continuity in switching between any two frequencies* (i.e., no switching transient) with a programming delay of only 1.5 μs before switching. Thus, linear frequency sweeping or frequency hopping (including FSK signaling) are easily programmed with the 5100 and 5110.

Features
Excellent spectral purity is also possible with digital synthesis since output distortion is determined entirely by the number of bits per sample and the linearity of the D/A converter. Another feature of digital synthesis is the ability to precisely control the phase of output frequency. In the Models 5100 and 5110 the phase may be asynchronously reset to zero at any time for as long as desired (or as little as 125 ns). Hence, for example, sinusoidal bursts are easily produced with each burst beginning at exactly zero phase.

Systems
Multi-channel systems, such as the System 36, and the modular synthesizer, Model 5101, are also available. Consult the factory for details.

*U.S. Patent 3,735,269

MODELS 5100 & 5110 FREQUENCY SYNTHESIZERS

FREQUENCY

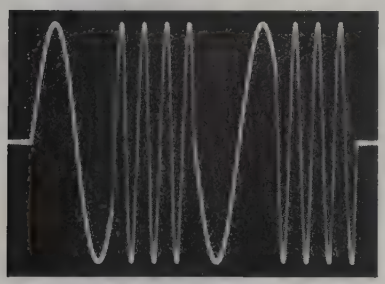
Range
DC to 2,000,000.000 Hz.
DC to 3,000,000.000 Hz (Option 013).

Resolution
Constant 0.001 Hz.

Control
Local: Ten 10-position rotary switches.
Remote: 31 bits in binary or 37 bits in BCD format.
Optional: GPIB. Model 1488A-12.

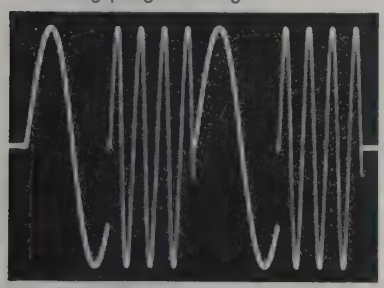
SWITCHING CHARACTERISTICS

Programming Delay
1.5μs per binary *word* with phase and amplitude continuity. 20 μs per BCD *word* with output reset to zero phase during delay.



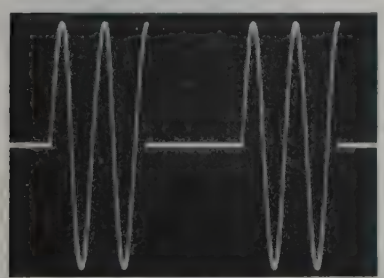
Binary Programming Mode.
(Note Amplitude and Phase Continuity is Maintained.)

20 μs minimum per 4 BCD and binary *bytes* with output reset to zero phase during programming.



BCD Programming Mode.
(Note Return to Zero Phase Between Steps.)

Update Rate
625 ns per binary *word*. 18 μs per BCD *word* and *byte* modes.



Sinusoidal Bursts with ZERO PHASE Line.

Zero Phase Reset
800 ns to and from ZERO phase (output asynchronously set to ZERO phase).

MAIN OUTPUTS (FRONT AND REAR PANEL BNC'S)

Fixed Output
Model 5100: 1Vp-p no load, 0.5 Vp-p into 50Ω.
Model 5110: 1Vrms, 0.5 Vrms into 50Ω.
Option 004: 10 Vp-p output replaces 1V fixed output (Model 5110 only).

Variable Output (Model 5100 only)
5 Vp-p into 50Ω (max).
10 Vp-p into open circuit (max).

Auxiliary Output
1 or 8 MHz square wave reference at TTL levels capable of driving 30 TTL loads.

Level Control
Model 5100 only: 0 to 85 dB attenuation in 1 dB steps plus 0 to 10 dB continuous control.
Option 002 (5100/5110): Remote program control (7 bits) of 85 dB attenuation in 1 dB steps from 0 to 85 dB.

SPECTRAL PURITY

Spurious Components
Standard: −70 dB to 100 kHz; −60 dB to 500 kHz; −50 dB to 2 MHz.
Option 013: −45 dB, 500 kHz to 2 MHz; −40 dB to 3 MHz.

Harmonic Components (at 1 Vrms)
Standard: −55 dB to 100 kHz; −50 dB to 500 kHz; −45 dB to 2 MHz.
Option 013: −40 dB, 500 kHz to 3 MHz.

Phase Noise
30 kHz band excluding 1 Hz centered on carrier.
Standard: −50 dB to 2 MHz.
Option 013: −40 dB, 2 MHz to 3 MHz.

Attenuator Response to 60 dB
±0.5 dB to 500 kHz.

CRYSTAL REFERENCES

Internal
8 MHz TCXO: Standard on Model 5100; (Option 006 for Model 5110).
Temperature Stability: $\pm 1 \times 10^{-6}$ from 0°C to +50°C.
Aging Rate: $\pm 5 \times 10^{-6}$/year.
Option 001 - High Stability (Oven Controlled)
Temperature Stability: $\pm 1 \times 10^{-8}$ from 0°C to 50°C.
Aging Rate: $\pm 2 \times 10^{-9}$/day.

External
External reference requires a TTL level input (1 TTL load) that is Schmitt-trigger conditioned.
1 MHz Reference: Phase locks to internal reference.
8 MHz Reference: Replaces internal crystal reference. Required for units without internal crystal reference (Model 5110 without options 001/006).
5/10 MHz reference: Please consult the factory.

GPIB

Model 1488A-12 provides following IEEE 488-1978 functions: AH1, L1 (listen only) DT1. Programs frequency (phase continuous) and amplitude (with option 002) as well as all ZERO PHASE modes.

GENERAL

Environment
Operating Temperature: 0°C to +50°C.
Storage Temperature: −20°C to +70°C.

Dimensions
Model 5100: 43.2 cm (17 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.
Model 5110: 48.3 cm (19 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.

Weight
9.6 kg (21 lb) net; 11.4 kg (25 lb) shipping.

Power
115/230V ±10%, 50 to 60 Hz, 65 watts.

OPTIONS

001: High Stability Crystal Reference
002: Remote Programmable Attenuator
004: 10 Vp-p Output
(Model 5110 only). Not available with option 013.
006: Temperature Compensated Crystal Reference
013: 3 MHz Frequency Range
(Original order only.)
020: Auxiliary TTL Output.
GPIB
Use Model 1488A-12.

ACCESSORIES

Rack Adapters
Programming Connector

FACTORY/FOB

San Diego, CA

PRICE

Model 5100	**$3850**
Model 5110	**$3250**
Model 1488A-12	**$925**
Option 001	**$895**
Option 002	**$525**
Option 004	**$75**
Option 006	**$275**
Option 013	**$475**
Option 020	**$475**

Programmable VHF Frequency Synthesizers

- **Frequency Range: 0.1 to 160 MHz**
- **Constant Resolution: 0.001 Hz**
- **High Speed, Spurious-Free Switching**
- **True Phase Continuity***
- **Direct Synthesis: No Phase-Lock Loops**

Performance and Versatility
The Models 5120A, 5130A and 5135A are precision frequency sources whose outputs are coherent with, and reflect the stability and accuracy of, either a 1, 5 or 10 MHz reference standard. Their sophisticated, high reliability design (MTBF >30,000 hours) combines the patented* *direct digital* synthesis technique of the Model 5100 with the field-proven *direct analog* synthesis methods.

The economical Model 5120A provides 0.1 Hz resolution and 20 μs switching speed. The Models 5130A and 5135A contains all the features of the 5120A plus phase-continuous frequency switching and finer resolution (under remote control). In addition, the Model 5135A offers very fast frequency hopping (<1 μs) that makes it the ultimate instrument for applications requiring frequency agility, such as FSK, coherent radar, and secure communications.

Remote Programming
All instruments provide the flexibility of standard BCD programming or an optional built-in GPIB interface. In the Models 5130A and 5135A, the remote programming extends the frequency resolution to 0.001 Hz.

Spurious-Free Switching
Frequency hopping of the digits below the 100 kHz increment maintains the spurious response specification even when frequencies are changed at a 20 kHz rate (higher rates up to 200 kHz are possible with no noticeable reduction in spurious response).

ATE Versions
Remote only versions of the Models 5120A, 5130A and 5135A are available for those applications not requiring front panel control. Specify the Models 5121A, 5131A or 5136A, respectively.

Systems
A multi-channel system, System 36, is available for higher frequencies than the normal output of the 5120A. Consult factory for details.

*U.S. Patent #3,735,269

MODELS 5120A, 5130A & 5135A FREQUENCY SYNTHESIZERS

FREQUENCY

Range
Local: 0.1 to 159,999,999.9 Hz
Remote: 0.1 to 159,999,999.9 Hz. (Model 5120A)
0.1 to 159,999,999.999 Hz. (Models 5130A/5135A)

Resolution
Local: 0.1 Hz.
Remote: 0.1 Hz (Model 5120A).
0.001 Hz (Models 5130A/5135A).

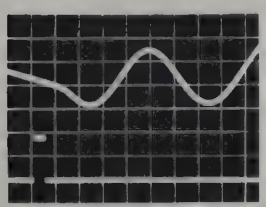
Control
Local by continuous rotary switches. Remote by TTL, parallel BCD, negative-true logic; remote enable line for all digits.

REMOTE PROGRAMMING

CHARACTERISTICS

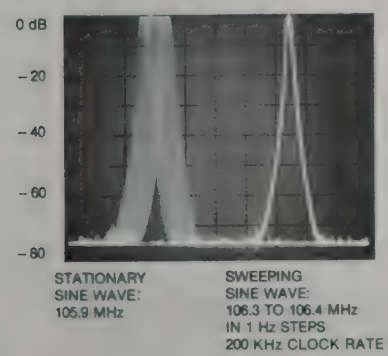
Switching Time*
Model 5120A: <20 μs
Model 5130A: 3-20 μs
Model 5135A: <1μs (digits <10 MHz), <5 μs (10 MHz digit).

Phase Continuity (Model 5130A/5135A)
Phase continuity maintained between chosen frequencies using any combination of the 8 digits below 100 kHz increment.



Phase Continuity

Switching Spurious (Model 5130A/5135A)
Spectral purity specification not degraded when switching frequencies below 100 kHz band, and using decades through 10 kHz only.



Spurious-Free Switching

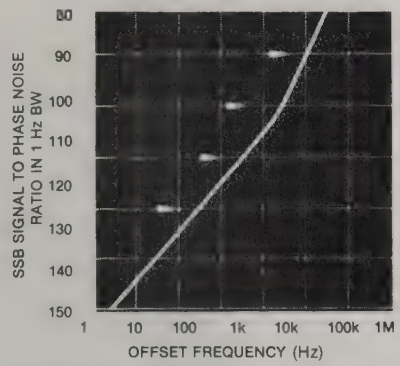
SPECTRAL PURITY

Non-Harmonic*
70 dB below fundamental, 0.1 MHz to 160 MHz (Typically better than 75 dB).

Harmonic*
35 dB below fundamental at full output, 1 MHz to 160 MHz (typically better than 40 dB).

Phase Noise Spectral Density*
Guaranteed SSB S/N ratio measured in 1 Hz bandwidth.

Offset Frequency	Guaranteed S/N
100 Hz	−100 dB
1 kHz	−110 dB
10 kHz	−120 dB
100 kHz	−125 dB



Typical Phase Noise Performance.

AMPLITUDE

Main Output
Level: Nominal level adjustable from +3 dBm to +13 dBm into 50Ω.
Flatness*: ±0.5 dB, 0.1 MHz to 160 MHz at +13 dBm.
Control: Local by continuous adjustment. Remote by external dc voltage; 0.6 to 2 V typical range from +3 dBm to +13 dBm.
Settling Time: 50 μs.

Auxiliary Reference Output
10 MHz, 0.4 Vrms nominal into 50Ω, approximately sinusoidal.

REFERENCE FREQUENCY

STANDARDS

External Reference Only (Option 000)
Internal 10 MHz Crystal
High Stability (Option 001)
Aging Range: $\pm 4 \times 10^{-9}$/day.
Temperature Stability: $\pm 1 \times 10^{-8}$, 0°C to 40°C.
TXCO (Option 002)
Aging Rate: $\pm 4 \times 10^{-6}$/year., 0°C to 40°C.
Temperature Stability: $\pm 1 \times 10^{-6}$, 0°C to 40°C.

External Input Capability
1 MHz (Option 007): Receives 1 MHz, 0.4 Vrms into 50Ω, nominal.
5 or 10 MHz (Standard): Receives 0.4 Vrms into 300Ω, nominal.

GENERAL

Environment
Operating Temperature: 0° to +40°C. Storage Temperature: −20°C to +70°C.

Dimensions
48.3 cm (19 in.) wide, 13.3 cm (5¼ in.) high, 48.3 cm (19 in.) deep. Includes rack ears.

Weight
15 kg (33 lb) net, 18 kg (40 lb) shipping.

Power
115/230 Vac ±10%, 50-400 Hz, 75 VA.

*These specifications are guaranteed. All other specifications are either nominal descriptions or typical values.

OPTIONS

One crystal option (000, 001 or 002) must be selected.
000: External Crystal Reference Only
001: High Stability Crystal Reference (Proportional Oven Control).
002: TCXO
Temperature Compensated Crystal Reference (TCXO).
003: Rear Panel Output
Rear panel output in lieu of front panel output.
006: IEEE 488-1978 Interface
Permits remote digital control of frequency and amplitude; follows standard protocol.
007: 1 MHz Ext Ref Input
Adds 1 MHz external reference input capability.
008: Chassis Drawer Slides

ACCESSORIES

BCD Programming Connectors (Models 5130A/5135A).

FACTORY/FOB

San Diego, CA

PRICE

Model 5120A	**$7195**
Model 5130A	**$8950**
Model 5135A	**$10,400**
Model 5121A	**$6995**
Model 5131A	**$8750**
Model 5136A	**$10,200**
Option 000	**N/C**
Option 001	**$850**
Option 002	**$425**
Option 003	**$50**
Option 006	**$850**
Option 007	**$425**
Option 008	**$250**

UHF Frequency Synthesizers

- **100 kHz to 1 GHz Frequency Range**
- **0.1 Hz Frequency Resolution**
- **As Low as 1 μs Switching Speed**
- **Phase Continuous Switching**
- **Very Low Close-in Phase Noise**

Remote and Local Control
Models 5155A and 5156A, Programmable UHF Frequency Synthesizers, combine patented* direct digital synthesis with time-proven direct analog techniques. Model 5155A is both front panel and remote programmable, while the 5156A, designed for OEM and ATE systems, is remote only.

Fast Switching
Standard BCD interface allows fast (less than 1 microsecond) phase-continuous frequency switching. Phase continuity is maintained for frequency changes less than 100 kHz. Fine frequency resolution of 0.1 Hz throughout the entire band and excellent close-in phase noise make the 5155A and 5156A ideal for signal multiplication. Their main output varies between +3 dBm and +13 dBm with 0.1 dB resolution.

Low Noise
Careful design layout and filtering have reduced the dynamic switching spurious response to the level of the static spurious response (−70 dBc) whenever phase continuous switching occurs. In addition, very low close-in phase noise (−100 dBc/Hz at 10 Hz offset frequency) is maintained below 500 MHz; performance that is not found in even more expensive synthesizers.

Applications
Whether as general purpose or dedicated instruments, Models 5155A/5156A are the right choice for a variety of applications. As local oscillators, they offer the simplicity, stability, and resolution to maintain performance in frequency coded radars. Secure communication transmissions need their fast spurious-free switching to make detection virtually impossible. For cellular radio requirements, low close-in phase noise, fast switching, and fine resolution make these instruments well suited in both testing and cell site maintenance.

*U S Patent 3,735,269

MODELS 5155A & 5156A FREQUENCY SYNTHESIZERS

FREQUENCY

Range
0.1 to 999,999,999.9 Hz.
Resolution
0.1 Hz.
Control (Model 5155A)
Keyboard entry in MHz, kHz, or Hz units.

MAIN OUTPUT

(Not specified below 500 kHz.)
Level
+3.0 dBm to +13.0 dBm into 50Ω (nominal).
Resolution
0.1 dB or 10mV.
Flatness* (At +13 dBm)
1 to 500 MHz: ±0.5 dB.
≥500 MHz: ±1 dB.
Control (Model 5155A)
Keyboard entry in dBm, V, or mV units.
RF Output On/Off (Model 5155A)
Illuminated button (>80 dB on/off ratio).
Connector
Model 5155A: Type N (front panel).
Option 003: BNC (rear panel).
Model 5156A: BNC (rear panel).

REFERENCE OUTPUT

Frequency
10 MHz.
Level
0.4 Vrms into 50Ω, approximately sinusoidal.

DISPLAY (Model 5155A)

Frequency
10 digit LCD readout in Hz with fixed decimal point for 0.1 Hz resolution.

Output Level
3 digit LCD readout for 3.1 to 13.0 dBm or 0.32 to 1.00V.

DISPLAY MODIFIER (Model 5155A)

Control
Illuminated on/off button causes rightmost digit to blink.
Digit Select
Left/right arrows (◄ ►) select digit to be modified by shifting blinking digit.
Modify Digit
Increments/decrements (▲ ▼) selected digit. Output updated as display changes.

SPECTRAL PURITY

Non-Harmonic*
<500 MHz: −70 dBc.
≥500 MHz: −64 dBc.
Harmonic (At +13 dBm)
<500 kHz: Not specified.
≥500 kHz: −20 dBc*
(−25 dBc typical).

Residual SSB Phase Noise (f = 500 MHz)**

Offset Frequency	Guaranteed S/N (dBc/Hz)
10 Hz	−90
100 Hz	−100
1 kHz	−110
10 kHz	−120
100 kHz	−125

Offset Frequency	Typical S/N (dBc/Hz)
10 Hz	−100
100 Hz	−110
1 kHz	−115
10 kHz	−125
100 kHz	−130
1 MHz	−130

REMOTE PROGRAMMING CHARACTERISTICS

Logic
TTL, parallel BCD, negative-true logic with double buffering.
Frequency Control
10 digits; 5 separate strobe lines for paired digits.
Output Level Control
2 digits with remote strobe through separate 14 pin connector.
00 to 99 corresponding to +13 to +3.1 dBm output.
GPIB (Option 006)
Models 5155A: SH1, AH1, T6, TE0, L3, LE0, SR1, RL2, PP1, DC1, DT0, C0, E1.
Model 5156A: SH0, AH1, T0, TE0, L1, LE0, SR0, RL0, PP0, DC2, DT1, C0, E1.
Programming Delay
<10 MHz increment: 2 μs (nominal)
Switching Transient*
<10 MHz increment (digit): 1 μs.
10 MHz Increment: 75 μs.
> 10 MHz increment: 100 μs
Phase Continuity*
Phase continuous for any frequency change using only the 6 increments (digits) below 100 kHz
Amplitude Settling Time
50 μs

REFERENCE FREQUENCY STANDARDS

Internal 10 MHz
None Supplied (Option 000)
External reference must be supplied.
High Stability (Option 001)
Aging Rate: $\pm 4 \times 10^{-9}$/day.
Temperature Stability: $\pm 1 \times 10^{-8}$, 0°C to +40°C.
TCXO (Option 002)
Aging Rate: $\pm 4 \times 10^{-6}$/year.
Temperature Stability: $\pm 1 \times 10^{-6}$, 0°C to +40°C.

External Reference Input
5 or 10 MHz (Standard):
0.4 Vrms into 50Ω (nominal).
1 MHz (Option 007):
0.4 Vrms into 50Ω (nominal).

GENERAL

Environment
Operating Temperature: 0°C to +40°C.
Storage Temperature: −20°C to +70°C.
Dimensions
48.3 cm (19 in.) wide; 13.3 cm (5¼ in.) high; 48.3 cm (19 in.) deep; includes rack ears.
Weight
18 kg (40 lb) net; 21 kg (44 lb) shipping.
Power
115/230 Vac ± 10%, 47 to 440 Hz; 85 VA.

OPTIONS

One crystal option (000, 001, or 002) must be selected.
000: External Reference Only
No internal frequency reference; external capability only.
001: High Stability Crystal Reference
See Reference Frequency Standards.
002: TCXO Reference
Temperature compensated crystal reference. (See Reference Frequency Standards.)
003: Rear Panel BNC Output (5155A)
Replaces front panel type N connector.
006: GPIB (IEEE 488-1978)
In addition to BCD programming.
007: 1 MHz External Reference Input
Adds 1 MHz to standard 5 and 10 MHz external reference capability.
008: Rack Slides

ACCESSORIES

BCD Programming Connectors (P/N 351-5001 50-pin male and 351-1401 14-pin male.

*These specifications are guaranteed. All other specifications are either nominal descriptions or typical values

**Reduce specifications by 6 dB for frequencies above 500 MHz

FACTORY/FOB

Contact San Diego, CA

PRICE

Model 5155A	**$14,950**
Model 5156A	**$14,450**
Option 000	**N/C**
Option 001	**$850**
Option 002	**$425**
Option 003	**$50**
Option 006	**$850**
Option 007	**$425**
Option 008	**$250**

Economical 400 & 500 MHz Sweepers

- **1 to 400 MHz Frequency Range (Option to 500 MHz)**
- **Calibrated Output (+10 to −55 dBm)**
- **Built-in RF Detector**
- **Complete Crystal Marker System**

1 to 400 MHz Frequency Range
The 1060 Series of sweep generators are economical, laboratory quality, broadband sweepers designed to meet the needs of engineering, production and maintenance facilities, and educational institutions.

These small, compact sweepers will sweep any portion of their wide, 1 to 400 MHz frequency range. RF output is controlled by a calibrated 20 dB continuously variable PIN diode attenuator and a 10 dB per step 50 dB turret attenuator.

This series offers variable sweep rates, triggering capability, and either 50 or 75Ω source impedance.

Marker System
The marker system accepts up to six crystal controlled plug-in marker modules, allowing either fixed single frequency, and/or harmonic (comb) type markers. The marker amplitude and bandwidth can be adjusted by varying the front-panel controls.

Full Performance
The units are extraordinary sweepers, providing 10 mW RF output, 2% sweep linearity and ±0.25 dB flatness. These features are typically found only in sweepers selling for much more.

Expanded Range CATV Version
Model 1067-522, a 75Ω instrument tailored to the CATV industry, extends the RF frequency range to 500 MHz. It is a very desirable tool for CATV test applications.

RF FREQUENCY

Frequency Range
Models 1062, 1067: 1 to 400 MHz.
Model 1067-522: 1 to 500 MHz.

Dial Calibration
50 MHz intervals (fine frequency vernier included).

Accuracy
5% full scale.

Sweep Width
0.2 to 400 MHz.

Display Linearity
2%.

Operating Modes
Sweep and CW.

Drift
Less than:
100 kHz for 5 minutes;
2 MHz for 8 hours.
NOTE: At a constant temperature after ½ hour warm-up.

RF OUTPUT

Impedance
Model 1062: 50Ω.
Model 1067: 75Ω
Model 1067-522: 75Ω.

Power Level Range
Model 1062: +10 to −60 dBm.
Model 1067, 1067-522: +57 to −7 dBmV.

Output Flatness
±0.25 dB (at 10 dBm).

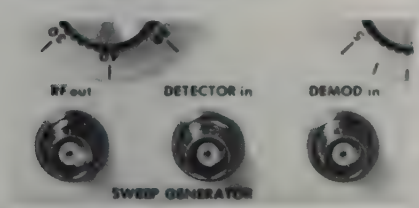
Attenuation
Range: 65 dB total; 50 dB in 10 dB steps plus 0 to 15 dB PIN diode attenuator.
Accuracy:
Step Attenuator: ±0.2 dB/10 dB.
Vernier Attenuator: ±1 dB.

Output Connector Type
Model 1062: BNC.
Models 1067, 1067-522: F.

Spectral Purity
Harmonic and nonharmonic, <30 dBc (10 to 400 MHz).

Residual FM
Less than 10 kHz peak.

SWEEP CHARACTERISTICS



Built-in Detector

Sweep Modes
Recurring, single sweep and trigger.

Sweep Rate
Continuously variable from less than 0.5 Hz to greater than 60 Hz.

Horizontal Output
10 Vp-p symmetrical about ground.

Blanking
Blanking of RF output during retrace; removed for CW operation.

MARKER SYSTEM

RF Markers
Provision for up to 6 crystal controlled plug-in birdy bypass marker modules (see Options A-1, A-2 and A-3).

Marker Switches
Individual on/off switches are in the following combination. The first three pushbuttons control the first three markers; the fourth switch controls the fourth and fifth markers. The sixth marker position is always on; it is normally used for the external marker module, Option A-3.

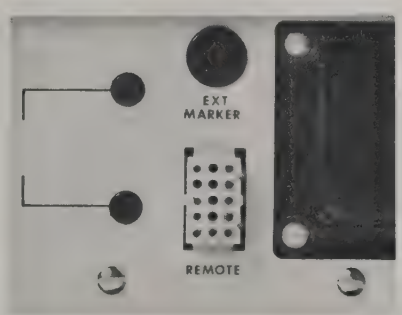
Accuracy
±0.005%.

Amplitude
Adjustable from approximately 2 mV to 2 Vp-p.

Width
Adjustable from approximately 100 to 400 kHz.

REMOTE PROGRAMMING

Rear panel jack connections for remote control of center frequency, sweep width and 0 to 20 dB vernier level control.



Rear Panel Inputs

GENERAL

Dimensions
28.6 cm (11 in.) wide; 10.2 cm (4 in.) high; 26.7 cm (10½ in.) deep.

Weight
3.7 kg (8¼ lb) net; 6.8 kg (12½ lb) shipping.

Power
115 or 230V ±10%; 50 to 400 Hz; approximately 25 watts.

OPTIONS

A-1 **$105**
Single Frequency Marker.
1 to 500 MHz. Specify frequency.

A-2 **$125**
Harmonic Type Marker.
Comb type frequency markers at 1, 5, 10, 50 or 100 MHz. Specify frequency.
NOTE: Harmonic type 0.1 MHz markers with associated 1.0 MHz markers are available. $250

A-3 **$105**
External Marker.
Marker provided by combining a CW signal (0.1V min. into 50Ω) from an external source through a rear panel BNC connector with a sample of the sweep oscillator signal.

ACCESSORIES

K015 **$75**
Rack Mount Adapter.
(P/N 1019-00-0119)

FACTORY/FOB

Beech Grove, IN

PRICE

Model 1062	**$1690**
Model 1067	**$1690**
Model 1067-522	**$2085**

1000 MHz Single Band Sweepers

- **Frequency Range 1 to 1000 MHz**
- **CW, ΔF and Full Sweep Modes**
- **Digital Readout**
- **1% Display Linearity**
- **Auto Zero**

Series 1080 compact and economical sweep generators feature simple operation, 1% display linearity, digital readout and three operating modes: CW, ΔF and full sweep. Models 1080 and 1081 have the same frequency range but different power output levels.

CW, ΔF, Full Sweep
Frequency in CW mode is set by a ten-turn control and displayed with 1 MHz resolution on a 3½ digit display. In ΔF mode, sweep width range (200 kHz to 1000 MHz max) is set by a 100 MHz/Step selector and a 100 MHz vernier. In full sweep mode, the frequency control and display operate as a variable marker.

Power Output
Model 1080 has an output power range of +13 to −70 dBm into 50Ω and is continuously adjustable with a 10 dB/Step attenuator and an 11 dB vernier. Output level is displayed on a 3½ digit readout with 0.1 dB resolution. An "auto-zero" circuit improves frequency accuracy. Model 1081 is a 75Ω version with a calibrated output of +60 to −10 dBmV.

Marker System
The birdy bypass marker system in the Series 1080 is controlled by a front-panel switch for selection of harmonic markers at 1, 10 and 100 MHz. Differences in marker amplitudes make identification of markers easy, and marker width is adjustable for optimum wide and narrow band operation. A calibrated variable marker is provided in the full sweep mode. External marker input is standard.

FREQUENCY

Range
1 to 1000 MHz.

Readout
3 ½ digit vacuum Fluorescent display.

Resolution
1 MHz.

Accuracy
CW, Center Frequency of ΔF, and Variable Marker: ±10 MHz. Frequency accuracy can be improved to ±1 MHz at a specific frequency.
Sweep Width at 100 MHz Intervals: ±10 MHz.

Sweep Width
ΔF, 200 kHz to 1000 MHz.
Full Sweep: Same as range.

Display Linearity
1% at maximum sweep width.

Operating Modes
CW, ΔF, and Full Sweep

Drift
<200 kHz for 10 min.
NOTE: At a constant temperature after ½ hour warm up.

RF OUTPUT

Impedance
Model 1080: 50Ω.
Model 1081: 75Ω.

Power Level Range
Model 1080: +13 to −70 dBm.
Model 1081: +60 to −10 dBmV.

Output Flatness
±0.25 dB.

Attenuation
Continuously adjustable in 10 dB steps with an 11 dB vernier. Output level is displayed on a 3 ½ digit readout with 0.1 dB resolution.

Accuracy
Step Attenuator: ±0.3 dB +1% of attenuation.
Vernier Attenuator: ±0.5 dB.

Output Connector
Type BNC.

SPECTRAL PURITY

Harmonic Output
1 to 2 MHz: <−15 dBc;
2 to 10 MHz: <−25 dBc;
10 to 1000 MHz: <−30 dBc in 1 to 2000 MHz band.

Nonharmonics
1 to 400 MHz: <−50 dBc;
400 to 1000 MHz: <−35 dBc.

Residual FM (CW Mode)
<10 kHz peak.

SWEEP CHARACTERISTICS

Sweep Modes
Recurring and single sweep.

Sweep Time
Fast: 0.010 to 1s (typical).
Slow: 1 to 100s (typical).
Line: Approximately ½ of AC line period.

Horizontal Output
0 to 10V, 1000Ω impedance.

Blanking
RF output is blanked during sweep retrace.

MARKER SYSTEM

RF Markers
Birdy bypass marker system is controlled by front-panel switch which provides selection of harmonic markers in these combinations: 100 MHz only; 100 MHz and 10 MHz; or 100 MHz, 10 MHz and 1 MHz.

Accuracy
±0.005%.

Amplitude
Adjustable from approximately 1 mV to 250 mVp-p.

Width
Adjustable from approximately 10 to 500 kHz.

Variable Marker
(Full Sweep Mode Only.) 10-turn potentiometer and 3½ digit frequency display function as a variable marker. Marker produces a bright spot on the display by momentarily delaying sweep ramp for approximately 2 ms. Accuracy is ±10 MHz.

External Marker
BNC input accepts CW signal for conversion to a birdy marker. Input level must be ⩾100 mV into 50Ω.

REMOTE PROGRAMMING

Frequency
Rear-panel jack permits remote control of center frequency, sweep width and external frequency modulation.

Level
Rear-panel jack permits external control of RF output level over greater than 13 dB range.

Trigger
TTL input, during high to low transition. Also, by contact closure to ground

OUTPUTS

Pen Lift
Contact closure during sweep

Blanking
−15V during sweep, +15V during retrace

Sweep
0 to 10V.

Reference
Output of 1V/100 MHz

Power Supply
+18V, −18V, and common. External current limited to 10 mA.

GENERAL

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high, 26.7 cm (10½ in.) deep.

Weight
4.9 kg (10.8 lb) net; 6.8 kg (15 lb) shipping.

Power
90 to 110V; 105 to 125V;
190 to 220V; or 210 to 250V;
50 to 60 Hz; approximately 35 watts.

ACCESSORIES

K019 **$75**
Rack Mount Kit adapts the instrument for center mounting in a standard 19 in. rack. 6 31/32 in. height.

FACTORY/FOB

Beech Grove, IN

PRICE

Model 1080	**$3550**
Model 1081	**$3550**

VHF/UHF Sweep/Signal Generator

- **1 to 1000 MHz Frequency Range**
- **Calibrated Output (+57 to −33 dBmV)**
- **Excellent Flatness and Linearity**
- **Complete Crystal Marker System**
- **Features for CATV Applications**

Versatility
Solid state Model 1801C Sweep/Signal Generator provides features and options ideally suited for the manufacturer of TV and CATV equipment and for the installers and operators of CATV systems. Model 1801C's 1 to 1000 MHz frequency range is standard.

Calibrated Output
The ultra-flat (±0.25 dB, 1 to 1000 MHz) 75Ω output system is calibrated from +57 to −33 dBmV. A three position front-panel level switch permits the output level to be increased or decreased by an identical fixed amount (internally adjustable to provide changes ranging from ±0.05 to ±0.5 dB). This feature aids in flatness measurements by providing an accurate, rapid calibration reference which is unaffected by the return loss of the test device or system. A dc block on the RF output prevents accidental equipment damage.

Marker System
The crystal controlled birdy marker system may be used to modulate (blank) the RF output so both sweep and markers may be on a single cable. This is very useful for an accurate frequency indication when sweeping long lines or cable systems.

Sweep Rate Versatility
Model 1801C will sweep at line frequency or as slow as 1 sweep in 100 seconds. In addition, a special sweep rate position provides a variable 1 to 10 ms sweep that repeats every 1 to 10 seconds. This is ideal for simultaneous sweep testing of operating cable systems with minimum subscriber interference. Model 1801C may be used with any available sweep receiver.

Special CATV Features
Model 1801C can operate in conjunction with Model 1075 or 1076 Comparator-Attenuator. When Model 1075 is plugged into Model 1801C, the PIN diode attenuator is time shared with the equalization, tilt and 0.1 dB attenuator by the comparator.

RF FREQUENCY

Range
1 to 1000 MHz.

Dial Calibration
20 MHz/div with 20 MHz vernier.

Accuracy
20 MHz.

Sweep Width
200 kHz to 1000 MHz.

Display Linearity
1%.

Spurious Signals
– 30 dB above 10 MHz.

Residual FM
<10 kHz peak in CW mode.

Drift
(At constant temperature after ½ hour warm-up.)
<100 kHz/5 minutes;
2 MHz for 8 hours.

RF OUTPUT

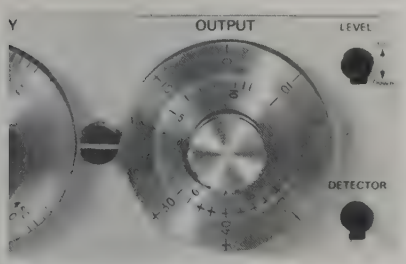
Maximum Output Amplitude
+ 57 dBmV 0.7 Vrms.

Impedance
75Ω (50Ω available).

Output Flatness
± 0.25 dB, 1 to 1000 MHz.

Attenuation
Continuously adjustable from + 57 to – 33 dBmV. 70 dB in 10 dB steps plus a 20 dB PIN diode attenuator calibrated in 1 dB increments.

Accuracy
± 0.5 dB to 500 MHz.
± 1.0 dB to 100 MHz.



Calibrated RF Output

Reference Attenuator
Internally adjustable from 0 to 0.5 dB above and below output level.

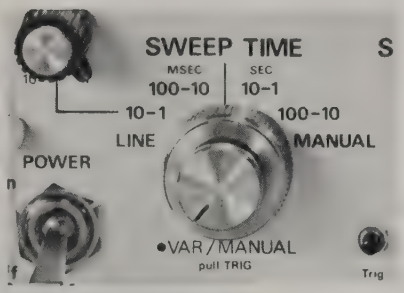
Slope Adjustment
To compensate for external cables, detectors, etc., up to ± 1 dB/GHz of slope may be imposed on the RF output via the front panel slope control.

Output Connector
Type BNC (type F available).

SWEEP CHARACTERISTICS

Sweep Modes
Recurring, single sweep, external trigger, manual and line lock.

Sweep Time
Continuously variable from 10 to 100 ms and from 1 to 100s, plus a special variable 1 to 10 ms sweep time range with an associated variable 1 to 10s repetition rate for testing of operating CATV systems.



Cable System Sweeping

MARKER SYSTEM

RF Markers
Provision for up to 6 crystal-controlled plug-in birdy bypass markers, plus rear-panel external marker input. Markers may be either discrete frequency (Option A-1) or harmonic type (Option A-2).

Accuracy
0.005%.

Amplitude
Adjustable from approximately 1 mV to 1 Vp-p.

Width
Adjustable from approximately 15 to 400 kHz in 4 steps.

REMOTE PROGRAMMING

Rear-mounted jack provides connections for remote control of center frequency, sweep width and 0 to 20 dB vernier level control.

External FM
± 16 V results in full deviation at rates up to 4 kHz. With reduced deviation and linearity, modulation rates up to 100 kHz are possible.

External AM
0 to – 5 V signals are applied to 20 dB vernier output attenuator. With average voltage set to midrange, modulation possible to 50 kHz.

External Leveling
External negative signal (ALC) between 0.2 and 2 V may be used to level RF output.

External Triggering
10 V pulse will trigger a single sweep

GENERAL

Dimensions
20.9 cm (8¼ in.) wide; 14.3 cm (5¾ in.) high; 34.9 cm (13¾ in.) deep.

Weight
9.1 kg (20 lb) net; 11.4 kg (25 lb) shipping.

Power
115 or 230 V ± 10% (available for 100 to 200 V at no extra cost); 50 to 400 Hz, approximately 20 watts.

OPTIONS

A-1 **$105**
Single Frequency Marker.
1 to 1000 MHz. Specify frequency.

A-2 **$125**
Harmonic Type Marker.
Comb type frequency markers at 1, 5, 10, 50 or 100 MHz. Specify frequency.

NOTE: Harmonic type 0.1 MHz markers with associated 1.0 MHz markers are available. $250.

ACCESSORIES

K103 **$55**
Rack Mount for Mounting One Unit. (P/N 1019-00-0028.)

K104 **$60**
Rack Mount for Mounting Two Units. (P/N 1019-00-0029.)

See page 172 for details.

FACTORY/FOB

Beech Grove, IN

PRICE

Model 1801C **$3525**

1400 MHz Sweeper

- **Wide Frequency Range**
- **Start/Stop, ΔF and CW Modes**
- **Calibrated RF Output System**
- **Calibrated Sweep Width**

1 to 1400 MHz Frequency Range
Model 2001 Sweep/Signal Generator offers versatility and a wide frequency range of 1 to 1400 MHz in a rugged, solid state instrument. Provision for complete remote programming and external AM or FM modulation is standard.

Multiple Operational Modes
Operating modes are Start/Stop, ΔF, and 100% duty cycle CW. In the ΔF mode, sweep width is read directly on the calibrated slide rule type dial.

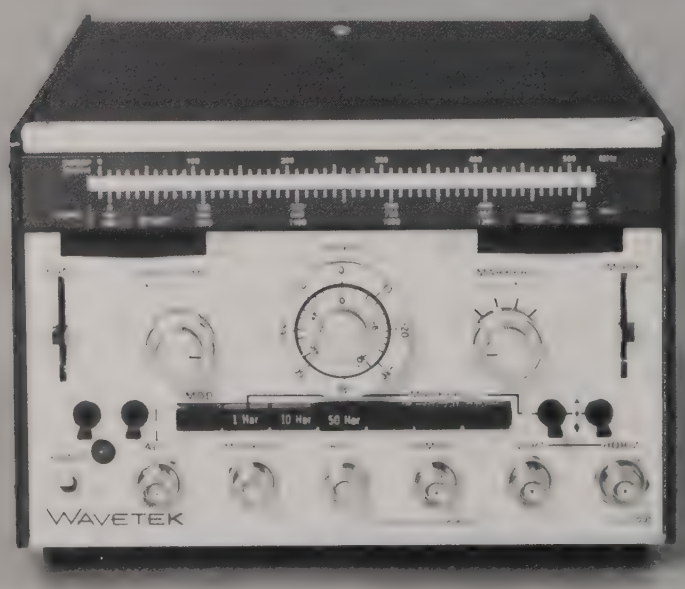
Sweep Rate Versatility
The three frequency bands are PIN diode switched and may be swept from CW to a full 500 MHz width. Sweep may be line locked or at rates of 50 sweeps per second to 1 sweep every 100 seconds. Manual and triggered modes are provided.

Calibrated RF Output
The high output (10 mW) is internally leveled to within ± 0.5 dB over the entire range and has provision for external leveling. The RF output system is calibrated from + 10 to − 80 dBm in 1 dB intervals.

Marker System
An optional crystal controlled birdy bypass marker system of up to six plug-in marker modules (each with individual of/off switches) may be added to the marker system. The markers may be at single discrete frequencies or at harmonically related frequencies (comb type markers).

All markers can be specified with the instrument or ordered at a later date for field installation. Size and width controls enable optimum adjustment of the marker display. In application, the markers may be tilted up to 90° for easy viewing when displayed with steep transition signals, or they may be rectified by a front panel switch for X-Y plotter applications. Model 2001 also converts a 100 mV external marker input signal to a birdy marker.

Model 2001 will interface with most network analyzers and attenuation test sets.



MODEL 2001 SWEEP GENERATORS

RF FREQUENCY

Frequency Range
1 to 500 MHz (band 1).
450 to 950 MHz (band 2).
900 to 1400 MHz (band 3).

Dial Calibration
10 MHz/div.

Accuracy
10 MHz (band 1).
2% of selected frequency (bands 2 and 3).

Sweep Width
200 kHz to 500 MHz.
Calibration in 10 MHz/div.

Operating Modes
ΔF, CW and Start/Stop.

Display Linearity
2%.

Spurious Signals
– 30 dB (10 to 1400 MHz).

Residual FM
Less than 7.5 kHz peak.

Drift
Less than:
100 kHz to 5 minutes;
1 MHz for 8 hours.
NOTE: At a constant temperature after ½ hour warm-up.

Blanking
Blanking of RF output during retrace; removed for CW operation.

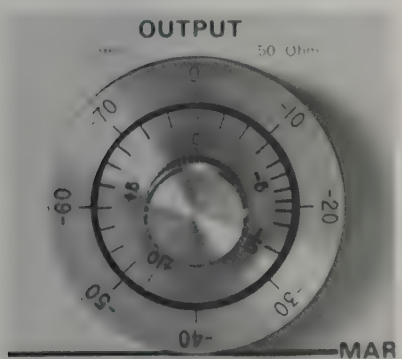
RF OUTPUT

Impedance
50Ω

Maximum Output Amplitude
+ 10 dBm.

Output Flatness
± 0.5 dB (at 10 dBm).

Attenuation
Continuously adjustable from + 10 to – 80 dBm. 70 dB in 10 dB steps plus a 20 dB PIN diode attenuator calibrated in 1 dB increments.



Attenuator

Accuracy
± 0.5 dB to 500 MHz.
± 1 dB to 1000 MHz.
± 2 dB to 1400 MHz.

SWEEP CHARACTERISTICS

Sweep Modes
Recurring, single sweep, external trigger, manual and line lock.

Sweep Time
Continuously variable from less than 10 ms to greater than 100s, in 4 decade steps, plus vernier.

Horizontal Output
16V p-p symmetrical about ground (0 to + 10V available upon request).

MARKER SYSTEM

RF Markers
Provision for up to 6 crystal controlled plug-in birdy bypass markers, plus external marker input. Markers may be either discrete frequency (Option A-1) or harmonic type (Option A-2).

Marker Switches
Individual on/off switches provided for each marker.

Accuracy
± 0.005%.

Width
Adjustable from approximately 15 to 400 kHz in 4 steps.

Amplitude
Adjustable from approximately 15 mV to 12V p-p and 100 μV to 50 mV p-p.

Marker Adjustment

Marker Tilt
Adjustable from vertical to approximately 90°.

External Marker
BNC input accepts CW signal for conversion to birdy marker. Input level must be at least 100 mV into 50Ω.

Recorder Processing
Front panel switch removes negative portion of birdy markers for use with X-Y recorders.

REMOTE PROGRAMMING

Rear mounted jack provides necessary connections for remote control of center frequency, sweep width and 20 dB vernier output control.

External FM
± 16V results in full deviation at rates up to 4 kHz. With reduced deviation and linearity, modulation rates to 100 kHz are possible.

External AM
0 to – 18V external signals are applied to 20 dB vernier output attenuator. With average voltage set to midrange, modulation possible to 50 kHz.

External Leveling
External negative signal (ALC) between 0.2 and 2V may be used to level RF output.

GENERAL

Dimensions
20.9 cm (8¼ in.) wide; 14.3 cm (5½ in.) high; 34.9 cm (13¾ in.) deep.

Weight
9.1 kg (20 lb) net; 11.4 kg (25 lb) shipping.

Power
115 or 230V ± 10% (available for 100 or 200V at no extra cost); 50 to 400 Hz; approximately 20 watts.

OPTIONS

A-1 **$105**
Single Frequency Marker.
1 to 1400 MHz. Specify frequency.

A-2 **$125**
Harmonic Type Marker.
Comb type frequency markers at 1, 5, 10, 50 or 100 MHz. Specify frequency.
NOTE: Harmonic type 0.1 MHz markers with associated 1.0 MHz markers are available. $250

ACCESSORIES

K103 **$55**
Rack Mount for mounting one unit (PN 1019-00-0028).

K104 **$60**
Rack Mount for mounting two units (PN 1019-00-0029).

FACTORY/FOB

Beech Grove, IN

PRICE

Model 2001 **$4025**

Bench and System X-Y Display

- **Large 12 Inch Diagonal CRT**
- **Ideal for Production Testing**
- **Excellent Sensitivity**
- **Economical**

Model 1901C is a low cost, electromagnetic, X-Y display scope ideal for use in displaying the sweep response of passive or active circuits. High performance and low cost make this scope an excellent choice for engineering laboratories, production facilities, educational institutions, and original equipment manufacturers of such devices as medical instrumentation and automotive test equipment.

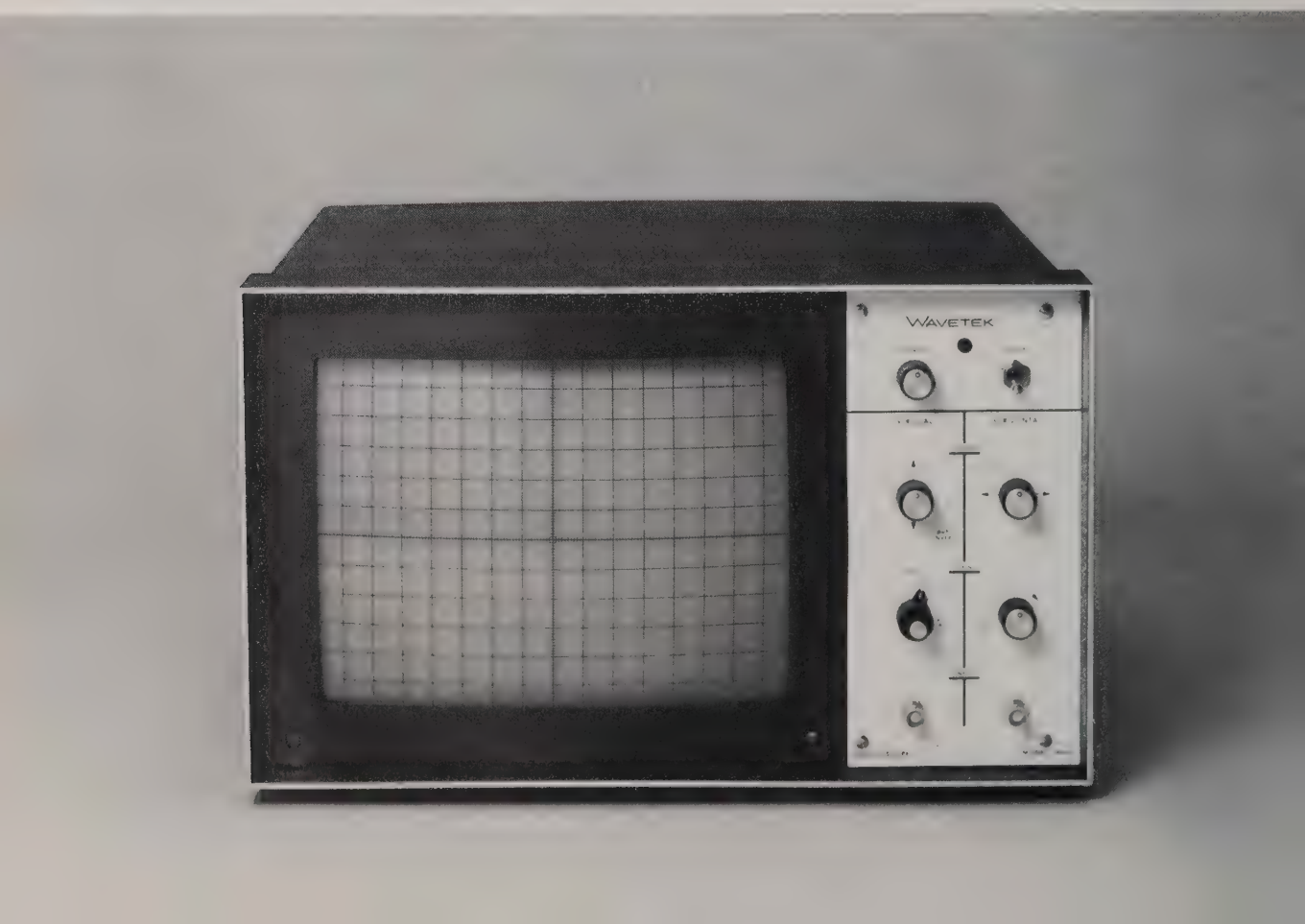
Features

Model 1901C is a single trace, general purpose scope. It may be intensity modulated and used either on the bench or rack mounted for production use.

Model 1901C features a large 12 inch diagonal screen which produces a bright, stable, focused trace for ease of viewing. An automatic blanking circuit prevents phosphor damage by blanking the CRT when the horizontal input is removed. Medium persistence phosphor (P1) is standard.

Model 1901C features Z-axis intensity modulation for grey scale operation.

Model 1901C also features a marker adder which accepts both birdy and pulse markers. Marker amplitude is constant regardless of vertical gain.



MODEL 1901C DISPLAY OSCILLOSCOPE

DISPLAY

CRT
12-in. (30 cm) diagonal.

Phosphor
P1 (medium persistence, green).

Graticule
1.5 cm/div, 12 cm vertical, 16 cm horizontal.

Deflection
Magnetic.

Acceleration Voltage
9 kV nominal.

VERTICAL

Sensitivity
4-position step attenuator for 1, 10, 100 mV and 1 V/div; continuously variable vernier between steps.

Impedance
374 kΩ.

Bandwidth
DC to 15 kHz.

Coupling
Switchable AC-DC (when AC coupled, maximum DC voltage plus AC peak not to exceed 200 V).

Linearity
5% (center 10 div).

Input Connector
BNC, front panel.

Drift
Typically <1/2 div for 8 hr (at a constant temperature after 1/2 hr warm-up).

Polarity
Front-panel switch for inversion of vertical signal.

HORIZONTAL

Sensitivity
Continuously adjustable from 0.1 V/div to over 10 V/div.

Impedance
>320 kΩ.

Bandwidth
DC to 1.5 kHz.

Coupling
Switchable AC-DC (when AC coupled, max DC voltage plus AC peak not to exceed 200 V).

Linearity
3%.

Input Connector
BNC, front panel.

Drift
Typically <1/2 div for 8 hr (at a constant temperature after 1/2 hr warm-up).

Protection Circuit
Prevents burnout of CRT by blanking beam when horizontal signal is < approximately 4 div (60 Hz rate). When operating at slower rate, or for servicing, rear-panel switch can disable the protection circuit.

Intensity Modulation

INTENSITY MODULATION (Z AXIS)

Sensitivity
Adjustable from 1 to 10 V for full modulation.

Input Impedance
20 kΩ in parallel with 10 pF.

Bandwidth
Flat from DC to 1 MHz; 3 dB down at 3.5 MHz, 10 dB down at 10 MHz.

Polarity
Positive going voltage intensifies trace. Internally changeable for positive blanking.

Input Connector
BNC at rear panel.

MARKER ADDER

Input Signal
Pulse or birdy

Sensitivity (Max)
Typically 0.5 V/div (continuously adjustable with rear-panel control).

Polarity
Rear-panel switch provides polarity reversal.

Input Impedance
Approximately 15 kΩ.

GENERAL

Dimensions
26.2 cm (10 5/16 in.) high; 41.9 cm (16 1/2 in.) wide; 36.2 cm (14 1/4 in.) deep.

Weight
11.8 kg (26 lb) net; 15 kg (35 lb) shipping

Power
115 or 230 V ± 10%; 50/60 Hz; approximately 75 watts

ACCESSORIES

K107 **$40**
Rack Mount P/N 1019-00-0030.

FACTORY/FOB

Beech Grove, IN

PRICE

Model 1901C **$995**

Group Delay Analyzer

- **Direct Readout of Group Delay**
- **Broad Band Coverage from 5 to 1500 MHz**
- **Internal Calibrator**
- **Pass Band Viewing**

Direct Readout of Group Delay
Model 4501 Group Delay Analyzer, which utilizes swept frequency techniques, reads group delay by measuring the phase shift of the modulating envelope of an amplitude modulated RF carrier as it passes through the device under test. This phase shift is converted to a voltage directly proportional to time delay, suitable for display on a long-persistence Model 4602 Display Oscilloscope. The signal may also be digitized and stored in memory when used in an automatic test system.

Broadband Coverage
Model 4501, when used with a Wavetek Sweep Generator and the Model 4602 Display Oscilloscope, indicates variations in group delay over the desired operating frequency of the device under test. This eliminates time-consuming point-by-point measurements and elaborate computations. Model 4501 is a real time instrument where the effects of changes in group delay and passband insertion loss of the D.U.T. may be observed as they occur. This is especially useful during manufacturing or when optimizing a device design.

22,000 Nanosecond Offset
Small variations of less than 1 nanosecond may be observed in the presence of large group delays by offsetting as much as 22,000 nanoseconds fixed group delay with front-panel controls. Wavetek Model 2002B Sweep Generator and the Model 4602 Display Oscilloscope are recommended for use with the Model 4501; although it may also be used with the Model 1080 Sweeper and any suitable X-Y Display Oscilloscope.

MODEL 4501 GROUP DELAY ANALYZER

Frequency Range
5 to 1500 MHz.

RF Input Level
3 dBm ±3 dB.

Modulator Output Level
(With ±3 dBm input.)
5 to 100 MHz: −20 dBm ±3 dB.
100 to 1500 MHz: −17 dBm ±3 dB.

Demodulator Input Level
(35 dB dynamic range.)
−42 dBm to −7 dBm.

Insertion Loss
Range: 20 dB.
Flatness:
(Measured at maximum positive input slope.)
5 to 1500 MHz: ±3 dB.

Group Delay
Range: 30 dB (20 dB attenuation, 10 dB gain).
Frequency Response:
5 to 20 MHz: ±20 ns.
20 to 100 MHz: ±3 ns.
100 to 1000 MHz: ±3 ns.
1000 to 1500 MHz: ±3 ns.

Accuracy:
5 to 100 MHz: ±4.5% ±3 ns.
100 to 1500 MHz: ±2% ±5 ns.

Displayed Noise
Unfiltered: 2 ns rms.
Video Filtered: 1 ns rms.

Connectors
Type "N" standard; other types optional.

RF Terminal Impedance
50 or 75Ω (specify when ordering).

Output Dynamic Range
±2.5V.

Maximum Sweep Rate
10 Hz.

Maximum Delay Offset
22,000 ns.

Calibrator Range
10, 100, 1000 ns.
(No calibration routine if calibrated display is used.)

Output Drift
20 ns/hr after 1/2 hr warm-up. (This will not affect a relative tg measurement.)

Automatic Offset and Drift Cancellation
Samples trace at center of sweep, compares to reference, and gates offset control to keep trace on screen.

Output Impedance
1000Ω DC coupled.

Horizontal Input
0 to 10 V.

GENERAL

Temperature Operating Range
25° ± 5°C.

Dimensions
13.4 cm (5¼ in.) high; 20.9 cm (8¼ in.) wide; 48.3 cm (19 in.) deep.

Weight
7.2 kg (16 lb).

Power
115 or 230V ±10%; 50 to 400 Hz; approximately 50 watts.

MODEL 4602 DIGITAL DISPLAY

Display
CRT: 17.7 cm (7 in.) diagonal display.
Pixels: 460 vertical by 512 (each channel) horizontal.
Phosphor: P20.
Graticules: Electronically generated. When fixed graticule mode is selected: 15 vertical by 12 horizontal.

Vertical Channel
(Channel A and Channel B)
Input Voltage Range: (Four position selectable) 1.0 V/div; 0.1 V/div; 0.01 V/div; 0.001 V/div. Vernier control will have at least a 10:1 attenuation. Full clockwise (CAL position) will produce minimum attenuation.
Frequency Response:
Analog: DC to 10 kHz.
Digital: Depends on max sweep rate of sweep generator used. At a sweep rate of 10 Hz, max input frequency should be limited to <2.5 kHz.
Slew Rate: 10 V/ms min.
Input Impedance: 1 MΩ nominal shunted by 30 pF max.
Vertical Position: Adjustable by a rear-panel control.

Horizontal Channel
Sweep source is external to display coming from sweep generator being used.
Voltage Range: 0 to 10V.
Sweep Rate: 10 Hz max.

Marker Channel
This channel is compatible with marker signals from Model 2002B or Model 1080 sweepers.
Detection Process: Level detection of detected marker envelope.
Minimum level: 1.2 Vp-p.
Display Mode: Marker display is implemented using pin-ball markers representing position of marker within sweep. Selectable by front-panel switch.

GENERAL

Dimensions
18.4 cm (7¼ in.) high; 20.9 cm (8¼ in.) wide; 48.3 cm (19 in.) deep.

Weight
9.5 kg (21 lb).

Power
115 or 230V ±10%; 50 to 400 Hz; approximately 85 watts.

FACTORY/FOB

Beech Grove, IN

PRICE

Model 4501	**$5245**
Model 4602	**$2395**

Scalar Analyzer System

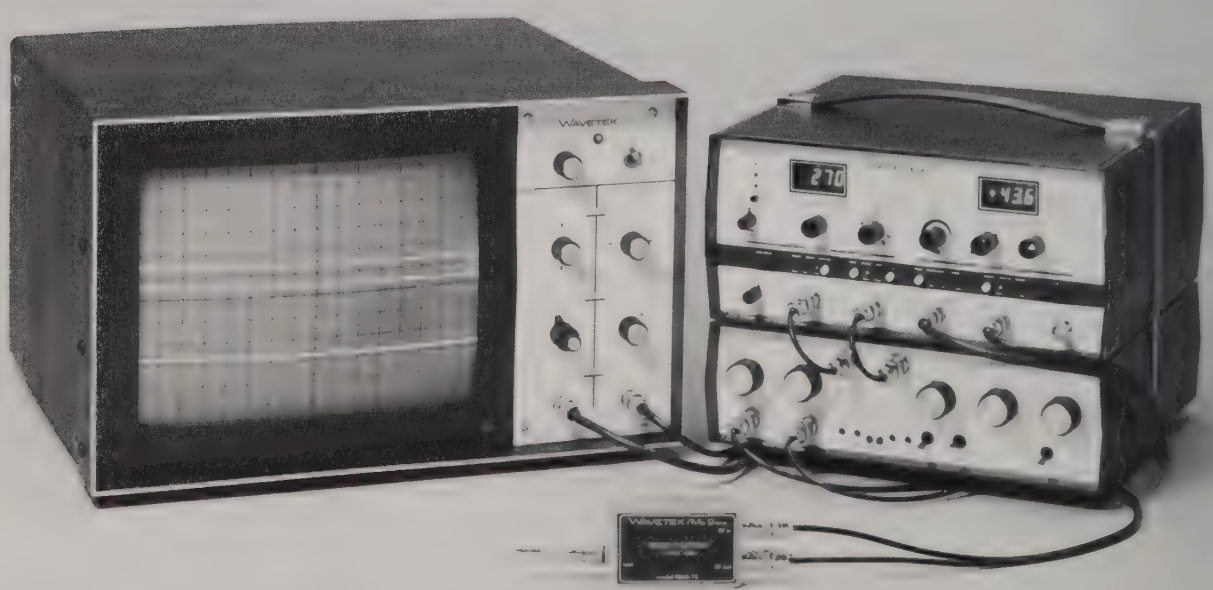
- **Sweeps 1 MHz to 1 GHz in a Single Band**
- **Broadband Search Mode**
- **System Level Correction**
- **Versatile Display**

Wavetek's Scalar Analyzer System is a versatile, low-cost system especially well suited for production testing. A real-time, broadband swept system, it provides highly accurate measurement at any frequency from 1 MHz to 1 GHz. The system is available in either 50Ω or 75Ω impedance.

System Components
The system consists of a sweep frequency source, Model 1080 (1081 is 75Ω); a calibrated dual-channel switching RF comparator, Model 1077 (1076 is 75Ω); an RF return loss Bridge, Model FB40-50 (FB40-75); and a large-screen oscilloscope, Model 1901C, to simultaneously display both test and reference channels.

Measurement to 1 GHz in a Single Band
The system sweeps from 1 MHz to 1 GHz in a single band. One oscillator is used to cover the whole band, eliminating errors introduced by switching transients used in other systems. Harmonic markers of 100 MHz, 10 MHz and 1 MHz help identify frequencies easily and accurately at any point in the sweep band. The size of the markers may be controlled to optimize readability and resolution.

Broadband Search Mode
After identifying a point of interest on a wideband response curve, the user may quickly switch to a preset narrow sweep around the marker frequency. When the passband of a device under test is not known, the full sweep mode may be used



to locate the passband and the variable marker may then be moved to coincide with the center of the passband. A simple, push-button control changes the mode to ΔF around the center frequency.

System Level Correction
Inaccuracies found in test setups caused by high-frequency rolloff of system components (such as adapters, cables, or "lossy" connectors) may be compensated for via the slope control on either the Model 1080 (1081) Sweep Generator or the Model 1077 (1076) RF Sweep Comparator. By looking at the detected response of this network, the operator can adjust the slope control (±1 dB/GHz) to compensate for inherent system errors which typically result in undesirable high-frequency rolloff. Absolute gain or loss measurements of the device under test are now possible with this step.

Absolute accuracy is determined by precision attenuators in each channel. Excellent trace coincidences of 0.3 dB allow very accurate relative measurements between the unknown and the reference or test channels. Use of a common internal detector, amplifier, and cable, virtually eliminates errors due to drift. A cable set to connect the device under test is matched to internal cables to minimize errors normally encountered when connecting the device under test.

Measurement of gain or loss at any frequency is made by allowing the reference and test traces to be superimposed. Gain is measured to 79.9 dB by attenuating the test channel until the traces meet. Loss is measured to 65 dB by attenuating the reference channel. Resolution is 0.1 dB.

Versatile Display
A switch on the front panel of the Wavetek Model 1077 (1076) RF Sweep Comparator controls the choice of linear, logarithmic or unshaped vertical display. Logarithmic display provides a typical dynamic range of 40 dB required to test very sharply tuned devices.

FREQUENCY

Range
1 MHz to 1 GHz in one band.
Sweep Width
Δ: 0.2 to 1000 MHz.
Full Sweep: same as range.
Display Linearity
1% at maximum sweep width.
Drift
Measured at constant temperature, after 1/2 hour warm-up.
<200 kHz for 10 min.
Operating Modes
CW, ΔF and Full Sweep.

RF OUTPUT

Impedance
50Ω or 75Ω.
Power Level Range
50Ω: +13 to −70 dBm.
75Ω: +60 to −10 dBmV.
Output Flatness
±0.25 dB

AMPLITUDE VS. FREQUENCY

Gain Measurement Range
0 to 79.9 dB (resolution: 1 dB).
Loss Measurement Range
0 to >60 dB (resolution: 0.1 dB).

Step (dB)	Accuracy (dB)	
	2 To 500 MHz	1 To 1000 MHz
0.1	±0.10	±0.20
1	±0.10	±0.25
10	±0.50	±1.00

Trace Coincidence
2 to 500 MHz: ±0.2.
1 to 1000 MHz: ±0.3.

REMOTE PROGRAMMING

Frequency
Center frequency and sweep width control.
Level
RF output level control over >13 dB range.

FB40-50/FB40-75

Impedance
Model FB40-50: 50Ω.
Model FB40-75: 75Ω.
Open-Short Change
±1.2 dB.
Insertion Loss
15 dB nominal
Directivity
>40 dB.
Connectors
BNC connectors are standard. Contact factory for other options.

GENERAL

Dimensions
Model 1080/1081: 13.3 cm (5 1/4 in.) high; 28.6 cm (11 1/4 in.) wide; 26.7 cm (10 1/2 in.) deep
Model 1076/1077: 10.2 cm (4 in.) high, 28.6 cm (11 1/4 in.) wide; 26.7 cm (10 1/4 in.) deep.
Model 1901C: 26.2 cm (10 15/16 in.) high; 41.9 cm (16 1/2 in.) wide; 36.2 cm (14 1/4 in.) deep.
Model FB40-50/FB40-75: 5 cm (2 in.) high; 11.5 cm (4 1/2 in.) wide; 3.2 cm (1 1/4 in.) deep.
Weight
Model 1080/1081: 4.9 kg (10.8 lb) net; 6.8 kg (15 lb) shipping.
Model 1076/1077: 3.0 kg (6.5 lb) net; (10 lb) shipping.
Model 1901C: 11.8 kg (26 lb) net; 15 kg (35 lb) shipping.
Model FB40-50/FB40-75: 0.35 gram (10 oz) net; 2.3 kg (5 lb) shipping
Power
Model 1080/1081: 90 to 110 V; 105 to 125 V; 190 to 220 V; or 210 to 250 V; 50 to 400 Hz; approx 35 watts
Model 1076/1077: Supplied by associated sweep
Model 1901C: 115 or 230 V ±10%; 50 or 60 Hz; approx 75 watts
NOTE: For more information
Model 1080: page 102,
Model 1081: page 102,
Model 1901C: page 108,
Models FB40-50, FB40-75, 1076, 1077 consult factory

FACTORY/FOB

Beech Grove, IN

PRICE

Scalar Analyzer System (50Ω)	
Model 1080	**$3550**
Model 1077	**$1875**
Model 1901C	**$995**
Model FB40-50	**$445**
Scalar Analyzer System (75Ω)	
Model 1081	**$3550**
Model 1076	**$1875**
Model 1901C	**$995**
Model FB40-75	**$445**

520 MHz Signal Generator

- **1 to 520 MHz Frequency Range With 1 kHz Resolution**
- **Phase-Lock Stability Over Entire Range**
- **Built-In Frequency Programmability**
- **Internal and External AM/FM Capability**

Versatility
Model 3000 Signal Generator is a rugged, completely solid-state instrument covering the VHF frequency range of 1 to 520 MHz. Ease of operation and exceptional accuracy, stability, dynamic range and AM/FM capability are the key features of this high value unit.

High stability signals are accurate to 0.001% in CW and AM modes. In FM mode, frequency is accurate to 0.001% ± 10 kHz up to 50 kHz peak deviation and 0.001% ± 45 kHz up to 500 kHz peak deviation. In AM mode, amplitude can be modulated to 90%.

Flexibility
Frequency is set via front panel lever/indicator switches to a resolution of 1 kHz. Remote frequency programmability is standard.

Output power is monitored on a front panel meter calibrated in both dBm and Vrms. A 15 position, 10 dB step attenuator used in conjunction with an 11 dB vernier control gives a range of +13 to −137 dBm. The calibrated output of Model 3000 is leveled to within ± 0.75 dB across its complete frequency range.

FREQUENCY

Range
1 to 520 MHz selectable in 1 kHz steps.

Readout
6 digit lever/indicator switches.

Resolution
1 kHz.

Accuracy
±0.001% in CW and AM modes. (Typical: ±0.0002% after 2 hr.)
±(0.001% +10 kHz) in FM × 1 mode.
±(0.001% +45 kHz) in FM × 100 mode.

Stability
0.2 ppm/hr in CW and AM modes.
500 Hz/10 min in FM × 1 mode.

Programmability
Frequency programmable through rear-panel input connector using BCD-coded TTL voltages or BCD-coded contact closures. Option 01C permits RF level programming.

RF OUTPUT

Power Level Range
+13 to −137 dBm (1V to 0.03 μV rms).

Level Control
Continuously adjustable in 10 dB steps with an 11 dB vernier. Output level is indicated on a front panel meter calibrated in volts and dBm.

Total Level Accuracy
+13 to −7 dBm: ±1.25 dB. (Typical: ±0.75 dB.)
−7 to −77 dBm: ±1.95 dB. (Typical: ±1.25 dB.)
−77 to −137 dBm: ±2.75 dB. (Typical: ±1.5 dB.)

Accuracy Breakdown
Flatness (+13 to −7 dBm): ±0.75 dB (Typical: ±0.5 dB.)
Output Meter: 0.5 dB.
Step Attenuator:
±0.5 to 70 dB (±0.2 dB calibration error).
±1.0 to 130 dB (±0.5 dB calibration error).

Impedance
50Ω (SWR <1.2 at RF output levels below 0.1V).

Leakage
<1 μV into a 2 turn, 1 in. diameter loop held 1 in. from any surface.

Output Connector
Type N.

SPECTRAL PURITY

Harmonic Output
1 to 10 MHz: <−26 dBc.
10 to 520 MHz: <−30 dBc.

Subharmonics
Nondetectable.

Nonharmonics

Fundamental	Spurious Level
1 to 3 MHz	<−60 dBc in 1 to 3 MHz band
3 to 250 MHz	<−65 dBc in 3 to 250 MHz band
3 to 350 MHz	<−55 dBc in 3 to 350 MHz band
3 to 520 MHz	<−35 dBc in 3 to 1000 MHz band

Residual AM
50 Hz to 15 kHz post-detection bandwidth: <−65 dBc.

Residual FM
300 Hz to 3 kHz post-detection bandwidth: <100 Hz (Typical: <50 Hz).
50 Hz to 15 kHz post-detection bandwidth: <200 Hz (Typical: <100 Hz).

AMPLITUDE MODULATION

Frequency
Internal (±5%): 400 Hz and 1 kHz.
External: DC to 20 kHz (±3 dB bandwidth). A 10V p-p signal into 600Ω is required to provide calibrated % modulation control.

Range
0 to 90%.

Distortion
Measured at 1 kHz.
0 to 70% AM: <3%. (Typical, 0 to 30% AM: <1.5%.)
0 to 90% AM: <5%.

Modulation Control
Calibrated from 0 to 90%.

Accuracy
±(5% +5% of reading) at a frequency of 1 kHz.

FREQUENCY MODULATION

Frequency
Internal (±5%): 400 Hz and 1 kHz.
External: DC to 25 kHz (±1 dB bandwidth). A 10V p-p signal into 600Ω is required to provide calibrated deviation control.

Peak Deviation Standard Ranges
0 to 5 kHz and 0 to 500 kHz. Other frequency deviation ranges available on special order.

Deviation Control Calibrations
0 to 5 kHz, ×1 and ×100.

Accuracy
±250 Hz on ×1 range.
±35 kHz on ×100 range.

Distortion
Measured at 1 kHz.
10 kHz to max deviation: <2%.
3 kHz to 10 kHz deviation: <4%.

GENERAL

Dimensions
30.3 cm (12 in.) wide; 13.4 cm (5¼ in.) high; 34.9 cm (13¾ in.) deep.

Weight
13 kg (28.6 lb) net; 13.6 kg (30 lb) shipping.

Power
115 or 230V ±10%; 50 to 400 Hz; approximately 40 watts.

OPTIONS

03 **$250**
Reverse Power Protection

ACCESSORIES

K108 **$55**
Rack Mount Adapter (P/N 1019-00-0031). See page 172 for details.

FACTORY/FOB

Beech Grove, IN

PRICE

Model 3000 **$2995**

520 MHz Signal Generator

- **100 Hz Resolution**
- **Phase Locked Over Entire Range**
- **Complex Modulation: AM/FM, FM/FM, AM/AM**
- **Four Internal Modulation Frequencies**
- **BCD Programmable**

Versatility
Model 3006 is a rugged, solid state, synthesized signal generator which incorporates unique modulation capabilities, excellent accuracy and stability, and many standard and optional features. The frequency range is 1 kHz to 520 MHz, with 100 Hz resolution.

Modulation Flexibility
Internal and external modulation capabilities provide unique complex, or simultaneous, modulation: FM on FM, AM on AM or AM on FM. This feature makes these Wavetek models ideal in tests of two-way radios, mobile telephones, paging receivers, and other systems that utilize techniques which superimpose subaudible tones or tone coded signals on voice (or other) channels.

Easily operated front panel controls allow the selection of not just two modulation frequencies (as in most generators), but four: the two standard frequencies of 400 Hz and 1 kHz, plus any other two, user-preset frequencies between 100 Hz and 10 kHz. Internal or external FM deviation (0 to 100 kHz) and percent AM modulation (0 to 90%) are easily set and read on the large, front panel meter. For increased readability and accuracy, two AM scales (30 or 100% full scale) and four FM scales (3, 10, 30, or 100 kHz full scale) are provided.

High Accuracy and Stability
Frequency of Model 3006 is set via seven level/indicator switches with 100 Hz resolution. Signal accuracy is 0.001% (typically 0.0002%) over their entire frequency range. Standard stability is 0.2 ppm/hour. Option 05, External Reference, allows accuracy over the entire frequency range to equal the accuracy of an external standard. Option 06, High Stability Reference, used in conjunction with Option 05 provides typical overall accuracy of 0.2 ppm (0.00002%) and aging of 0.005 ppm/day.

Programmability
Frequency programmability through rear panel input connector using BCD coded TTL voltages or BCD coded contact closures is standard. The programmability of Model 3006 makes it ideal for automatic and semi-automatic test applications.

MODEL 3006 SIGNAL GENERATORS

FREQUENCY

Range
1 kHz to 520 MHz.
Readout
Leveler/Indicator Switches: 7 digits.
Resolution
100 Hz.
Accuracy
±0.001% in all modes.
(Typical: ±0.0002% after 2 hours.)
Stability
0.2 ppm/hr. 500 Hz/10 min when frequency vernier is not in CAL position.
Programmability
Frequency programmability through rear-panel input connector using BCD-coded TTL voltages or BCD-coded contact closures is standard. Option 01C permits RF level programming.

RF OUTPUT

Power Level Range
+13 to −137 dBm (1V to 0.03 μV rms).
Level Control
Continuously adjustable in 10 dB steps with an 11 dB vernier. Output level is indicated on a front panel meter calibrated in volts and dBm.
Total Level Accuracy
+13 to −7 dBm: ±1.25 dB.
(Typical: ±0.75 dB.)
−7 to −77 dBm: ±1.95 dB.
(Typical: ±1.25 dB.)
−77 to −137 dBm: ±2.75 dB.
(Typical: ±1.5 dB.)
Accuracy Breakdown
Flatness (+13 to −7 dBm):
±0.75 dB (Typical: ±0.5 dB.)
Output Meter: ±0.5 dB.
Step Attenuator:
±0.5 to 70 dB (±0.2 dB cal. error);
±1.0 to 130 dB (±0.5 dB cal. error).
Impedance
50Ω (SWR <1.2 at RF output levels below 0.1V).
Leakage
<1 μV into a 2 turn, 1 in. dia. loop held 1 in. from any surface.

SPECTRAL PURITY

Harmonic Output
1 to 10 MHz: >26 dBc.
10 to 520 MHz: >30 dBc.
1 kHz to 1 MHz: >30 dBc.
Subharmonics
None detectable.
Nonharmonics

Fundamental	Spurious Level
1 kHz to 3 MHz	>60 dBc in 1 to 3 MHz band
3 to 250 MHz	>65 dBc in 3 to 250 MHz band
3 to 350 MHz	>55 dBc in 3 to 350 MHz band
3 to 520 MHz	>35 dBc in 3 to 1000 MHz band

Residual AM
>65 dB below carrier in a 50 Hz to 15 kHz post-detection bandwidth.
Residual FM
<100 Hz in 300 Hz to 3 kHz post-detection bandwidth. (Typical: <50 Hz.)
<200 Hz in a 50 Hz to 15 kHz post-detection bandwidth. (Typical: <100 Hz.)

AMPLITUDE MODULATION

Internal Frequency
400 Hz, 1000 Hz and two preset frequencies between 100 Hz and 10 kHz (accuracy: ±2%).
External Frequency
DC to 20 kHz (3 dB bandwidth). Input level required: 1V rms into 600Ω to provide full-scale adjustment with EXT MOD LEVEL control.
Range
0 to 90%.
Distortion
(Measured at 1 kHz.)
0 to 70% AM: <3%. (Typical, 0 to 30% AM: <1.5%.)
0 to 90% AM: <5%.
Meter
Scales of 30% AM and 100% AM.
Accuracy: ±(2% of full-scale reading +5% of meter reading) at 1 kHz modulation frequency.

FREQUENCY MODULATION

Internal Frequency
400 Hz, 1000 Hz and two preset frequencies between 100 Hz and 10 kHz (accuracy: ±2%).
External Frequency
50 Hz to 20 kHz (1 dB bandwidth) with frequency vernier in CAL. DC to 25 kHz (1 dB bandwidth) with frequency vernier not in CAL. Input level required: 1 Vrms into 600Ω to provide full-scale adjustment with EXT MOD LEVEL control.
Range
0 to 100 kHz deviation.
Distortion
(Measured at 1 kHz.)
10 kHz to Max Deviation: <2%.
3 kHz to 10 kHz Deviation: <4%.
Meter
Scales of 3, 10, 30 and 100 kHz deviation.
Accuracy: ±3% of full scale reading. (Measured with 1 kHz modulation.)

GENERAL

Output Connector
Type N.
Dimensions
30.3 cm (12 in.) wide; 13.4 cm (5¼ in.) high; 34.9 cm (13¾ in.) deep.
Weight
13 kg (28.6 lb) net; 13.6 kg (30 lb) shipping.
Power
115 or 230V ±10%; 50 to 400 Hz; approximately 40 watts.

OPTIONS

NOTE: Option combinations are restricted as shown on model/option availability chart (page 124). Options are described on this page also.

03 **$250**
Reverse Power Protection
05 **$275**
External Reference (Required with Option 06)
05A **$350**
External Reference/High Stability Reference (1 ppm accuracy)
06 **$720**
High Stability Reference (Requires Option 05)

ACCESSORIES

K108 **$55**
Rack Mount Adapter
(P/N 1019-00-0031). See page 172 for details.

FACTORY/FOB

Beech Grove, IN

PRICE

Model 3006 **$3995**

Signal Generator/Deviation Meter

- **1 kHz to 520 MHz with 1 kHz Resolution**
- **Front Panel FM Deviation Meter**
- **Modular Construction**
- **Reverse Power Protection**
- **Synthesized Signal Accuracy**

Capability
Model 3007 Signal Generator incorporates a complete 1 kHz to 520 MHz FM, AM and CW signal generator, and an FM deviation meter in one compact, ruggedized instrument. The combination of two instruments in one is ideal for testing both transmitters and receiver sections of the FM transceivers.

Signal Generation
The signal generator portion of Model 3007 is a synthesized signal source capable of being remotely programmed. The leveled RF output can be accurately controlled from +13 to −137 dBm through the use of a 10 dB per step attenuator with an 11 dB overlapping vernier. External and internal modulation capability allows for FM and AM operation.

Deviation Measurement
The deviation meter section of Model 3007 permits quick and accurate measurements of FM deviation. A green lamp lights in the presence of an RF signal at any level within the range of 10 mV to 5V rms to indicate a "go" condition for FM deviation measurement. Meter nulling is not critical. Any null less than "1" on the scale is sufficient. Two deviation ranges of 0 to 50 kHz and 0 to 500 kHz with + and − positions are provided to check deviation symmetry.

FREQUENCY

Range
1 kHz to 520 MHz selectable in 1 kHz steps.
Readout
6 digit leveler/indicator switches.
Resolution
1 kHz.
Accuracy
±0.001% in all modes.
(Typical: ±0.0002% after 1 hour.)
±0.001% ±10 kHz when frequency vernier is not in CAL position.
Stability
0.2 ppm/hr.
500 Hz/10 min when frequency vernier is not in CAL position.
Programmability
Frequency programmability through rear-panel input connector using BCD-coded TTL voltages or BCD-coded contact closures is standard.

RF OUTPUT

Power Level Range
+13 to −137 dBm (1V to 0.03 μV rms).
Level Control
Continuously adjustable in 10 dB steps with an 11 dB vernier. Output level is indicated on a front panel meter calibrated in volts and dBm.
Total Level Accuracy
+13 to −7 dBm: ±1.25 dB.
(Typical: ±0.75 dB.)
−7 to −77 dBm: ±1.95 dB.
(Typical: ±1.25 dB.)
−77 to −137 dBm: ±2.75 dB.
(Typical: ±1.5 dB.)
Accuracy Breakdown
Flatness (+13 to −7 dBm): ±0.75 dB.
Output Meter: ±0.5 dB.
Step Attenuator:
±0.5 to 70 dB (±0.2 dB calibration error).
±1.0 to 130 dB (±0.5 dB calibration error).
Impedance
50Ω (SWR <1.2 at RF output levels below 0.1V).
Leakage
<1 μV into a 2 turn, 1 in. diameter loop held 1 in. from any surface.

RF OUTPUT PROTECTION

Type
Resettable RF circuit breaker.
Frequency Range
1 kHz to 520 MHz.
RF Trip Voltage
5V rms nominal.
Maximum Reverse Power
50W (50V rms).
Trip Time
<2 ms.
Insertion Loss
<0.2 dB.

SPECTRAL PURITY

Harmonic Output
1 kHz to 10 MHz: >30 dBc.
1 to 10 MHz: >26 dBc.
10 to 520 MHz: >30 dBc.
Subharmonics
None detectable.
Nonharmonics

Fundamental	Spurious Level
1 kHz to 3 MHz	>60 dBc in 1 to 3 MHz band
3 to 250 MHz	>65 dBc in 3 to 250 MHz band
3 to 350 MHz	>55 dBc in 3 to 350 MHz band
3 to 520 MHz	>35 dBc in 3 to 1000 MHz band

Residual AM
>65 dB below carrier in a 50 Hz to 15 kHz post-detection bandwidth.
Residual FM
<100 Hz in 300 Hz to 3 kHz post-detection bandwidth. (Typical: <50 Hz.)
<200 Hz in a 50 Hz to 15 kHz post-detection bandwidth. (Typical: <100 Hz.)

AMPLITUDE MODULATION

Frequency
Internal (±5%): 400 Hz and 1 kHz.
External: DC to 20 kHz (±3 dB bandwidth). A 10 Vp-p signal into 600Ω is required to provide calibrated % modulation control.
Range
0 to 90%.
Distortion
(Measured at 1 kHz.)
0 to 70% AM: <3%. (Typical, 0 to 30% AM: <1.5%.)
0 to 90% AM: <5%.
Modulation Control
Calibrated from 0 to 90%.
Accuracy
8% maximum at a frequency of 1 kHz.

FREQUENCY MODULATION

Frequency
Internal (±5%): 400 Hz and 1 kHz.
External: 50 Hz to 100 kHz when frequency vernier in CAL position. DC to 100 kHz when frequency vernier is not in CAL position. A 10 Vp-p signal into 600Ω to provide calibrated deviation control.
Peak Deviation Standard Ranges
0 to 50 kHz and 0 to 500 kHz. Other frequency deviation ranges available on special order.
Deviation Control Calibrations
0 to 50 kHz, ×1 and ×10.
Accuracy
±2.5 kHz on ×1 range.
±25 kHz on ×10 range.
Distortion
(Measured at 1 kHz.)
3 to 100 kHz Deviation: <4%.

FM DEVIATION METER

Frequency Range
30 to 500 MHz.
Input Level Range
10 mV to 5V rms.
Impedance
50Ω.
Deviation Range
0 to ±50 kHz.
0 to 500 kHz.
Frequency Response
100 Hz to 8 kHz.
Deviation Accuracy
4% F.S. at 1 kHz.
6% F.S. from 100 Hz to 8 kHz.

GENERAL

Output Connector
Type N.
Environment
Meets the requirements of MIL-T-28800 for Type III, Class 5, Style E Equipment.
Dimensions
30.3 cm (12 in.) wide; 13.4 cm (5¼ in.) high; 34.9 cm (13¾ in.) deep.
Weight
13 kg (28.6 lb) net; 13.6 kg (30 lb) shipping.
Power
115 or 230V ±10%; 50 to 400 Hz; approximately 40 watts.

ACCESSORIES

K108 **$55**
Rack Mount Adapter
(P/N 1019-00-0031). See page 172 for details.

FACTORY/FOB

Beech Grove, IN

PRICE

Model 3007 **$6465**

1 to 1040 MHz Signal Generator

- **1 MHz to 1040 MHz Frequency Range**
- **GPIB Programmability**
- **32 Complete Front-Panel Stored Settings**
- **Nonvolatile Memory**
- **Programmable Internal Modulation Source**
- **50 Watt Reverse Power Protection**

Model 3510B, a microprocessor-controlled Signal Generator, covers the frequency spectrum of 1 to 1040 MHz. Standard features include a programmable internal audio source for AM and FM modulation, a nonvolatile memory and full GPIB programmability.

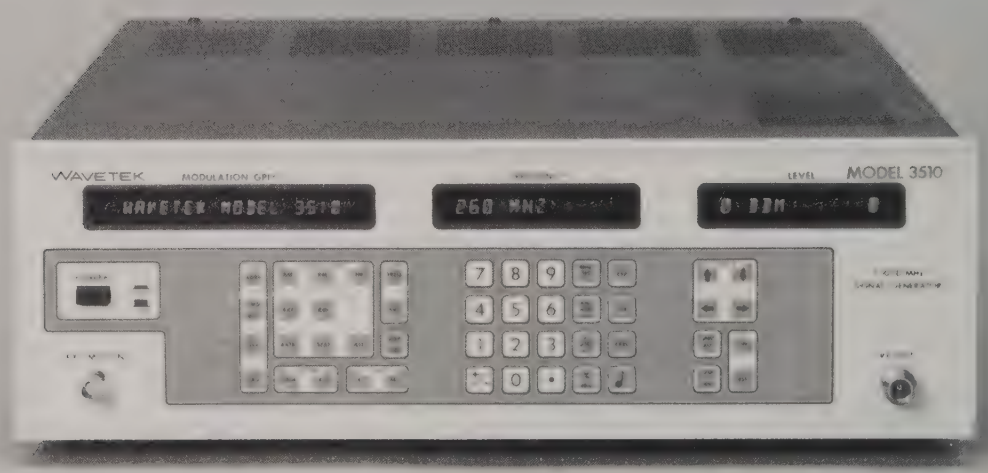
+13 dBm Output; 0.001% Frequency Accuracy
RF output power range is +13 dBm to −137 dBm with flatness to ±1 dB (+13 to −6.9 dBm). Frequency resolution is 100 Hz and accuracy is 0.001% (typically 0.0002%). The standard stability of 0.2 ppm/hr may be improved by using the optional External Reference input, the optional Internal/External Reference and/or the optional High Stability Internal Reference.

Modulation Flexibility
The internal modulation signal can be at any 10 Hz increment between 80 Hz and 10 kHz. This internal source may be combined with an external source to create complex or simultaneous modulation such as AM on FM, FM on FM or AM on AM.

Simple Operation
Manual control is via a 48-key touch pad front panel. A "beeper" indicates a button has been pressed. All settings are displayed. Output levels are conveniently read out in dBm or volts. Up to 32 complete front-panel settings may be stored in a nonvolatile memory and recalled to the front panel on command.

A unique cursor system has selectable increment sizes. A reference mode allows frequency or level references to be set; subsequent display values are relative to the reference value.

All functions are GPIB programmable except power on/off. Programming is "free format," and multiple function changes can be executed simultaneously. Frequency switching and settling time over the bus is typically 75 ms.



MODEL 3510B SIGNAL GENERATORS

FREQUENCY

Range
1 to 1040 MHz. (1 kHz to 1040 MHz optional.)

Resolution
100 Hz.

Accuracy
±0.001% in all modes with ALC on; ±(0.001% + 10 kHz) in all modes with ALC off.

Stability
(After 2 hr warmup)
1 to 520.9999 MHz: 0.2 ppm/hr with ALC on, 500 Hz/10 min with ALC off.
521 to 1000 MHz: 0.4 ppm/hr with ALC on, 1 kHz/10 min with ALC off.

Switching Speed
Typically <200 ms.
(<40 ms for steps >1 MHz).

RF OUTPUT

Impedance
50Ω (SWR less than 1.3 at RF levels less than 0.1 Vrms).

Output Connector
Type N.

Power Level Range
1 to 1000 MHz: +13 to −137 dBm (1 volt to 0.0316 μVrms).

RF Level Control
Adjustable in 0.1 dB steps in dBm mode. Three significant digits in voltage mode.

Total Level Accuracy (1 to 1000 MHz)
+13 to −36.9 dBm: ±1.3 dB below **−36.9 dBm:** ±(1.3 dB + 1% of step attenuation).

Accuracy Traits (1 to 1000 MHz)
Flatness (+13 to −6.9 dBm): ±1 dB, 1 to 1000 MHz.
Step Attenuator: ±0.3 dB or 1% of attenuation, whichever is greater.

Leakage
<1 μV into a two-turn, 1 inch diameter loop held 1 inch from any surface.

SPECTRAL PURITY

Harmonic Output
1 MHz to 10 MHz: < −26 dBc;
10 MHz to 1 GHz: < −30 dBc.

Sub-Harmonics
1 to 520.9999 MHz: none detectable;
521 to 1000 MHz: < −30 dBc.

Non-Harmonics

Fundamental	Spurious Level
1 to 3 MHz	< −60 dBc in 1 to 3 MHz band
3.0001 to 250 MHz	< −65 dBc in 3 to 250 MHz band
3.0001 to 350 MHz	< −55 dBc in 3 to 350 MHz band
3.0001 to 500 MHz	< −35 dBc in 3 to 1000 MHz band
3.0001 to 1000 MHz	< −30 dBc in 3 to 2000 MHz band

Phase Noise
1 to 520.9999 MHz: < −93 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
1 to 520.9999 MHz: < −120 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth);
521 to 1000 MHz: < −87 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
521 to 1000 MHz: < −114 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth);

Residual AM
< −60 dBc in a 50 Hz to 15 kHz post-detection bandwidth.

Residual FM
In 50 Hz to 15 kHz Post-Detection Bandwidth:
1 to 520.9999 MHz: <200 Hz (typically <100 Hz).
521 to 1000 MHz: <400 Hz (typically <200 Hz).

MODULATION

Internal Frequency Source
Internal modulation source settable in 10 Hz increments between 80 Hz and 10 kHz (accuracy ±6% + 2% of reading).

External Frequency Source
AM: DC to 30 kHz (3 dB bandwidth) with ALC off; 100 Hz to 30 kHz with ALC on.
FM: DC to 60 kHz (1 dB bandwidth) with ALC off; 100 Hz to 60 kHz with ALC on.
Input Level Required to Provide Calibrated Display:
ALC On: 0.1V to 1 Vp-p into 600Ω;
ALC Off: 10 Vp-p into 600Ω.

Modulation Depth Resolution
0.1%.

Modulation Depth Indicator Accuracy
0 to 90%: ±(2% + 4% of reading) at 1 kHz rate.

Modulation Range
0.1 to 90% (over range to 100%).

Modulation Distortion
(Measured at 1 kHz.)
0 to 30% AM: <1.5%.
30 to 70% AM: <3%.
70 to 90% AM: <5%.

Deviation Resolution
100 Hz for deviations <10 kHz.
1 kHz for deviations ≥10 kHz.

Deviation Indicator Accuracy
±(500 Hz + 5% of reading) at 1 kHz rate.

Deviation Range
0.1 to 100 kHz deviation.

Distortion
(Measured at 1 kHz.)
10 to 100 kHz deviation: <2%.
3 to 10 kHz deviation: <4%.

GPIB REMOTE PROGRAMMING

Conforms to IEEE-488 standards. Controls all functions except power On/Off.

Function
Listens and talks, gives error status and instrument status. Implements: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2.

GENERAL

Readout
Alpha-numeric vacuum-fluorescent display.

Front Panel Control
Soft touch membrane switches.

Reverse Power Protection
(No protection below 1 MHz).
Trip Time: <2ms.
RF Trip Level: Approx 0.7W.
RF: 50W.
DC Blocking Voltage: 50V.

Environment:
Specifications Apply: 25° ± 5°C.
Slight Degradation of Specifications: 25° ± 15°C.

Dimensions
43.2 cm (17 in.) wide × 14.6 cm (5¾ in.) high × 40.6 cm (16 in.) deep.

Weight
14.5 kg (32 lb).

Power
90 to 110, 110 to 130, 180 to 220, or 220 to 240 VAC; 50 to 400 Hz; approximately 75 watts.

OPTIONS

NOTE: Option combinations are restricted as shown on model/option availability chart (page 124). Options are described on this page also.

02A **$550**
External Pulse Modulation

05 **$275**
External Reference. Required with Option 06.

05A **$350**
External Reference/High Stability Reference.

06 **$720**
High Stability Reference

08 **$700**
Low Frequency Extension (1 kHz to 1040 MHz).

09 **$250**
Rear Panel RF Out and Mod In

ACCESSORIES

K234 **$75**
Rack Mount Kit (P/N1019-00-0234)
See page 172 for details

FACTORY/FOB

Beech Grove, IN

PRICE

Model 3510B **$5600**

1 to 2080 MHz Signal Generator

- **1 MHz to 2080 MHz Frequency Range**
- **GPIB Programmability**
- **32 Complete Front-Panel Stored Settings**
- **Non-volatile Memory**
- **Programmable Internal Modulation Source**
- **50 Watt Reverse Power Protection**

Model 3520, a microprocessor-controlled Signal Generator, covers the frequency spectrum of 1 to 2080 MHz. Standard features include a programmable internal audio source for AM and FM modulation, a non-volatile memory and full GPIB programmability.

+10 dBm Output with 0.001% Frequency Accuracy
RF output power range is +10 dBm to −137 dBm with flatness to ±1 dB (+10 to −6.9 dBm). Frequency resolution is 100 Hz to 1040 MHz and 200 Hz to 2080 MHz. Accuracy is 0.001% (typically 0.0002%). The standard stability of 0.2 ppm/hr may be improved by using the optional External Reference input, the optional Internal/External Reference and/or the optional High Stability Internal Reference.

Modulation Flexibility
The internal modulation signal can be at any 10 Hz increment between 80 Hz and 10 kHz. This internal source may be combined with an external source to create complex or simultaneous modulation such as AM on FM, FM on FM or AM on AM.

Simple Operation
Manual control is via a 48-key touch pad front panel. A "beeper" indicates a button has been pressed. All settings are displayed. Output levels are conveniently read out in dBm or volts. Up to 32 complete front-panel settings may be stored in a non-volatile memory and recalled to the front panel on command.

A unique cursor system has selectable increment sizes. A reference mode allows frequency or level references to be set; subsequent display values are then relative to the reference value.

All functions are GPIB programmable except power on/off. Programming is "free format," and multiple function changes can be executed simultaneously. Frequency switching and settling time over the bus is typically 115 ms.

MODEL 3520 SIGNAL GENERATORS

FREQUENCY

Range
1 MHz to 2080 MHz (1 kHz to 2080 MHz optional).

Resolution
100 Hz (1 to 1040 MHz);
200 Hz (1041 to 2080 MHz).

Accuracy
±0.001% in all modes with ALC on; ±(0.001% +10 kHz) in all modes with ALC off.

Stability
(After 2 hr warmup)
1 to 520.9999 MHz: 0.2 ppm/hr with ALC on, 500 Hz/10 min with ALC off.
521 to 1000 MHz: 0.2 ppm/hr with ALC on, 1 kHz/10 min with ALC off.
1000 to 2000 MHz: 0.2 ppm/hr with ALC on, 2 kHz/10 min with ALC off.

Switching Speed
Typically <275 ms (<115 ms for steps >2 MHz).

RF OUTPUT

Impedance
50Ω (SWR less than 1.3 at RF levels less than 0.1 Vrms).

Output Connector
Type N.

Power Level Range
+10 to −137 dBm (0.717V to 0.0316 μVrms).

RF Level Control
Adjustable in 0.1 dB steps in dBm mode. Three significant digits in voltage mode.

Total Level Accuracy
+10 to −36.9 dBm: ±2.0 dB.
Below −36.9 dBm: ±(2.0 dB +2% of step attenuation).

Accuracy Traits
Flatness (+10 to −6.9 dBm): ±1.5 dB
Step Attenuator: ±0.6 dB or 2% of attenuation, whichever is greater.

SPECTRAL PURITY

Harmonic Output
1 MHz to 520.9999 MHz: < −26 dBc;
521 MHz to 1000 MHz: < −30 dBc;
1000 to 2080 MHz: < −25 dBc.

Sub-Harmonics
1 to 520.9999 MHz: Nondetectable;
521 to 2080 MHz: < −30 dBc.

Non-Harmonics

Fundamental	Spurious Level
1 to 3 MHz	< −60 dBc in 1 to 3 MHz band
3.0001 to 250 MHz	< −65 dBc in 3 to 250 MHz band
3.0001 to 350 MHz	< −55 dBc in 3 to 350 MHz band
3.0001 to 520 MHz	< −35 dBc in 3 to 1000 MHz band
3.0001 to 2000 MHz	< −30 dBc in 3 to 4160 MHz band

Phase Noise
1 to 520.9999 MHz: < −93 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
1 to 520.9999 MHz: < −120 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth);
521 to 1040 MHz: < −87 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
521 to 1040 MHz: < −114 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth);
1041 to 2080 MHz: < −81 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
1041 to 2080 MHz: < −108 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth).

Residual AM
< −65 dBc in a 50 Hz to 15 kHz post-detection bandwidth.

Residual FM
(In 50 Hz to 15 kHz post-detection bandwidth.)
1 to 520.9999 MHz: <200 Hz (typically <100 Hz);
521 to 1040 MHz: <400 Hz (typically <200 Hz);
1041 to 2080 MHz: <800 Hz.

MODULATION

Internal Frequency Source
Internal modulation source settable in 10 Hz increments between 80 Hz and 10 kHz (accuracy ±6 Hz +2% of reading).

External Frequency
AM: DC to 30 kHz (3 dB bandwidth) with ALC off; 100 Hz to 30 kHz with ALC on.
FM: DC to 60 kHz (1 dB bandwidth) with ALC off; 100 Hz to 60 kHz with ALC on.
Input level required to provide calibrated display:
ALC On: 0.25 V to 1 Vp-p into 600Ω;
ALC Off: 10 Vp-p into 600Ω.

Modulation Depth Resolution
0.1%.

Modulation Depth Indicator Accuracy
0.1 to 90%: ±(2% F.S. +4% of reading).

Modulation Range
0 to 100%.

Modulation Distortion
Measured at 1 kHz:
0.1 to 30% AM: <1.5%.
30 to 70% AM: <3%.
70 to 90% AM: <5%.

Deviation Resolution
Deviations <10 kHz: 100 Hz;
Deviations ≥10 kHz: 1 kHz.

Deviation Range
0.1 to 100 kHz deviation.

Distortion
(Measured at 1 kHz)
10 to 100 kHz Deviation: <2%.
3 to 10 kHz kHz Deviation: <4%.

Frequency Deviation Accuracy
±(500 Hz + 5% of reading) at 1 kHz.

GPIB REMOTE PROGRAMMING

Interface conforms to IEEE-488 standard. Controls all functions except power on/off. Listens, talks, gives error and instrument status. Implements SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2.

GENERAL

Display Readout
Alpha numeric vacuum-flourescent.

Front Panel Control
Soft-touch membrane switches.

Reverse Power Protection
(No protection below 1 MHz).
Trip Time: <2ms.
RF Trip Level: Approx. 0.7W.
RF: 50 W.
DC Blocking Voltage: 50 V.

Operating Temperature
All Specifications Apply: 25° ± 5°C.
Slight Degradation: 25° ± 15°C.

Dimensions
43.2 cm (17 in.) wide; 14.6 cm (5¾ in.) high; 40.6 cm (16 in.) deep

Weight
14.5 kg (32 lb).

Power
90 to 110, 110 to 130, 180 to 220, or 220 to 240 Vac; 50 to 400 Hz; approximately 75 watts.

OPTIONS

NOTE: Option combinations are restricted as shown on model/option availability chart (page 124). Options are described on this page also.

02A **$550**
External Pulse Modulation

05 **$275**
External Reference. Required with Option 06.

05A **$350**
External Reference/High Stability Reference.

06 **$720**
High Stability Reference

08 **$700**
Low Frequency Extension (1 kHz to 2080 MHz)

09 **$250**
Rear Panel RF Out and Mod In

ACCESSORIES

K234 **$75**
Rack Mount Kit (P/N1019-00-234)

FACTORY/FOB

Beech Grove, IN

PRICE

Model 3520 **$7995**

Options for Signal Generators

02A: External Pulse Modulation
Frequency Range: 20 to 1040 (usable to 2080 MHz on 3520).
Modulation Rate: Up to 500 kHz.
Pulse On-Off Ratio: 40 dB min. (50 dB typical).
Minimum Pulse Time: 1 μs.
Rise/Fall Time: 200 ns.

PRICE: $550

05: External Reference
A rear panel BNC accepts an external frequency reference. Improves accuracy from 10 ppm to that of the external source. Frequency can be 1, 2, 2.5, 5 or 10 MHz. Minimum level 50 mV into 1 kΩ. Required with Option 06.

PRICE: $275

05A: External Reference/High Stability Reference
A rear-panel BNC accepts an external frequency reference (5 or 10 MHz, 0.5 50 5 Vrms). Used to improve accuracy from 10 ppm to that of the external source. Includes an internal TCXO ± 1 ppm accuracy which can be used in lieu of the external source and used to drive other devices requiring a high stability TTL input.

PRICE: $350

06: High Stability Reference
A high stability rear panel TTL output which can be used to drive Option 05. Option 06 can drive up to four other devices or instruments. Aging 0.005 ppm/day, 0.05 ppm/month, 0.3 ppm/year. Typical overall accuracy 0.2 ppm at 25 ±15°C. Option 05 is required.

PRICE: $720

08: Low Frequency Extension
Extends lower frequency range to 1 kHz.

PRICE: $700

09: Rear Panel (Only) RF Output and Modulation Input

PRICE: $250

3000 SERIES SIGNAL GENERATOR OPTION AVAILABILITY

Option	Signal Generator								
	3000	3006*		3007	3510B*		3520*	
02A: Pulse Modulation**					•		•	
05: External Reference			•			•		•
05A: External Reference/High Stability Reference (1 ppm)		•			•		•	
06: High Stability Reference (0.1 ppm) Option 05 required			•			•		•
08: Low Frequency Extension to 1 kHz					•	•	•	•
09: Rear Panel (Only) RF Output and Modulation Input					•	•	•	•

*Select options from within the same column.
**Consult Factory for Details.

Broadband Cable Communications Test Equipment

Wavetek has provided many years of leadership to the broadband cable communications test instrument industry. Wavetek's products offer greater versatility and performance than any other equipment available.

Dedicated to providing total service to the CATV and LAN markets, Wavetek is first in customer satisfaction, product development, product performance and product support.

Wavetek offers an extensive line of equipment to fill your broadband cable testing needs.

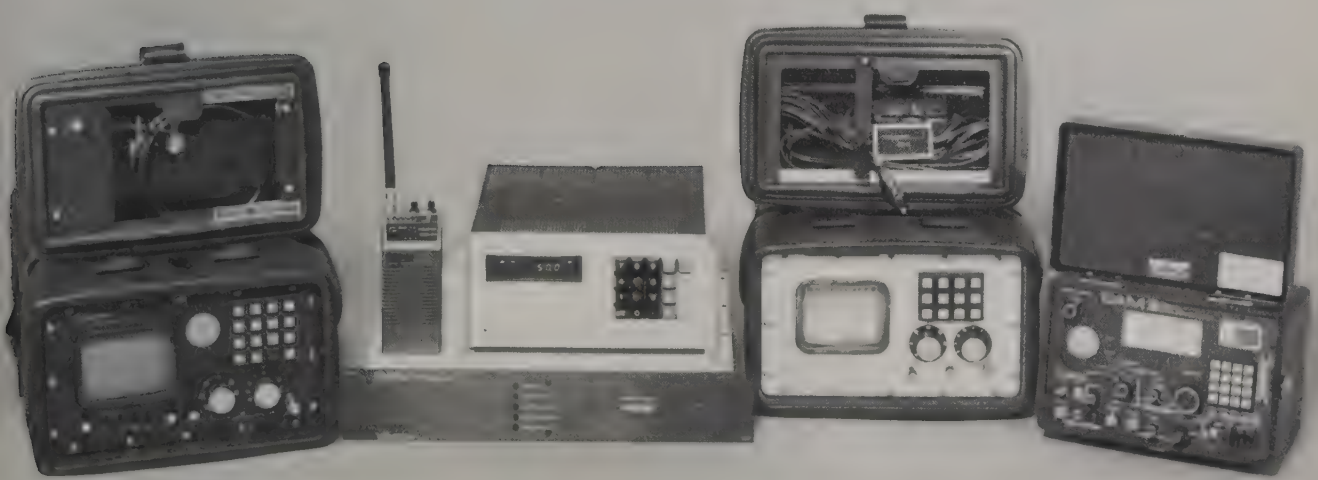
- Signal Level Meters
- System Analyzers
- System Sweep
- Leakage Detection
- Automatic Test Systems

For a complete catalog, call or write:

Wavetek Indiana, Inc.
5808 Churchman
P.O. Box 190
Beech Grove, IN 46107
Toll Free: 1-800-622-5515
In Indiana: (317) 788-5965

or

Wavetek Electronics GMBH
Hans-Pinsel-Strasse 9-10
8013 Haar bei Munchen
Federal Republic of Germany
Tel: (0 89) 46 50 62
Telex: 521-2966 + WVTK D



Wavetek produces many RF and microwave components. Featured here are:

- RF Detectors
- Tunable Bandpass Filters
- Turret Attenuators
- Step Attenuators

Other RF components include:

- Miniature Filters
- Tublar and LC Filters
- High Power Filters
- DC Blocks
- Custom Attenuators
- Programmable Attenuators
- High Power Attenuators
- Matching Pads

For an RF and Microwave Component catalog write or call:

Wavetek Indiana, Inc.
RF and Microwave Components
5808 Churchman
Beech Grove, IN 46107
Tel: (317) 788-5975
Toll Free: (800) 851-1202

RF Detectors

Series 150 and 170 Detectors are designed for applications requiring low VSWR and flat frequency response across broad operating ranges.

MODELS	D151	D152	D153	D171	M151
Frequency Range (MHz)	0.2 – 1000	0.2 – 2000	1.0 – 12,400	0 2 – 1000	0 2 – 1000
Impedance	50Ω	50Ω	50Ω	75Ω	50Ω
VSWR	1 15	1.5	1.2 - 4.5 GHz 1 3 – 7 0 GHz 1.4 – 12.4 GHz	1 15 (>23 dB return loss)	1 5
Max Input	3.0V	3 0V	100 mW	3 0V	3.0V
Output Polarity*	Negative*	Negative*	Negative**	Negative*	Negative*
Frequency Response (dB)	± 0 3	± 0.5	± 0 2/oct to 8 GHz ± 0 5 overall	± 0 3	± 0 5
Connectors RF Input DC Output	Male BNC Fem BNC	Male BNC Fem BNC	Male N Fem BNC	Male BNC Fem BNC	Fem BNC Fem BNC
Dimensions Diameter Length	1.4 cm 5.7 cm	1 4 cm 5 7 cm	2.1 cm 6.3 cm	1 4 cm 5 7 cm	1 4 cm 5 7 cm
PRICE (FOB Beech Grove)	$88	$125	$225	$90	$115

*May be reversed by reversing diode

**Order D153-P for positive output

Tunable Bandpass Filters

Wavetek's rugged Series 5200 Tunable Bandpass Filters are extensively used where wide band noise or harmonic rejection is required and for specific channel selection in diplexers and multiplexer applications.

SPECIFICATIONS

Frequency Range	Model
31 to 62 MHz	5201
62 to 125 MHz	5202
125 to 250 MHz	5203
250 to 500 MHz	5204
500 to 1000 MHz	5205
1 to 2 GHz	5206

Impedance
50Ω.
VSWR
1.5:1.
Insertion Loss
Less than 1.0 dB.
Form Factor
30 dB/3 dB, 2.5 maximum 2.2 typical.
Calibration Accuracy
± 1% of indicated frequency.
Power
60 watts maximum.
Connector
Type N female (other connectors available on request).
Dimensions
Models 5201 thru 5205: 13.9 cm (5-7/16 in.) wide; 7.1 cm (2-13/16 in.) high; 19 cm (7-5/8 in.) deep.
Model 5206: 8.9 cm (3-5/8 in.) wide; 7.1 cm (2-13/16 in.) high; 14.7 cm (5-11/16 in.) deep.
Dimensions do not include knobs, feet or connectors.
Weight
1.8 kg (4 lb) net; 2.3 kg (5 lb) shipping.

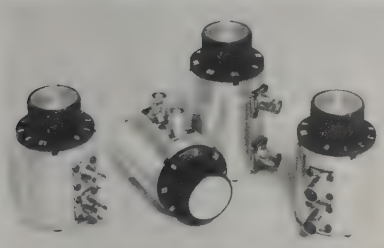
FACTORY/FOB

Beech Grove, IN

PRICE

Series 5200 $635

Turret Attenuators



The Series 5000 and 7500 Attenuators are miniature turret type units that operate over wide frequency ranges making them equally suitable for bench setups, field use, or in OEM test instrumentation.

Direct reading units with 0.1, 1.0, 5.0 and 10.0 dB steps are available in either 50 or 75 ohm version. The VSWR of all units is less than 1.2 up to 1000 MHz.

The 7500 Series Attenuators, designed primarily for the CATV industry, have VSWRs of less than 1.1 up to 500 MHz (26 dB return loss).

All units are ruggedly constructed and have provision for panel mounting.

MODELS	5001	5010	5035	5070	7501	7510	7535	7570
Attenuation (dB)	1 to 2 in 0.1 steps	0-10 in 1.0 steps	0-35 in 5.0 steps	0-70 in 0.1 steps	1 to 2 in 0.1 steps	0-10 in 1.0 steps	0-35 in 5.0 steps	0-70 in 10.0 steps
Frequency Range (MHz)	0 to 1200	0 to 2000	0 to 2000	0 to 2000	0 to 1000	0 to 1000	0 to 1000	0 to 1000
Impedance (Ohms)	50	50	50	50	75	75	75	75
Insertion Loss (dB)	1 dB + 0.3 max	0.3 max	0.3 max	0.4 max	1 dB + 0.2 max	0.2 max	0.2 max	0.3 max
Accuracy (dB)	±0.1	±0.2 to 500MHz ±0.3 to 1000MHz ±1.0 to 2000MHz	±0.5 to 500MHz ±1.0 to 1000MHz ±3.0 to 2000MHz	±0.3 to 500MHz ±1.0 to 1000MHz ±3.0 to 2000MHz	±0.1	±0.2	±0.5 to 500MHz ±1.0 to 1000MHz	±0.5 to 500MHz ±1.0 to 1000MHz
VSWR	1.25 max	1.2 max to 1000MHz, 1.5 max to 2000MHz			1.1 max to 2000MHz, 1.2 max to 1000MHz			
Max. Input Power (Watts)	3	1	½	½	3	1	½	½
Angle Between Steps	30°	30°	45°	45°	30°	30°	45°	45°
Connectors	BNC Female (SMA, TNC, N)				BNC Female (SMA, TNC, F)			
PRICE (FOB Beech Grove)	$87	$87	$87	$87	$87	$87	$87	$87

NOTES 1. Model 5001 and 7501 dial calibration is from 0 to 1 in 0.1 steps *2. All accuracy is with reference to the minimum loss position*

80 dB Step Attenuators

Models 5080 and 7580 are direct reading, dual concentric, turret-type attenuators that can be panel mounted. They are ideally suited for use in test sets requiring wide attenuation settings.

Models 5080.1 and 7580.1 Attenuator Sets are turret type, mounted in a cabinet for bench use.

MODELS	5080	7580	5080.1	7580.1*
Attenuation (dB)	0-80 in 1.0 steps	0-80 in 1.0 steps	0-81 in 0.1 steps	0-81 in 0.1 steps
Frequency Range	0 to 2000 MHz	0 to 1000 MHz	0 to 1000 MHz	0 to 1000 MHz
Impedance (Ohms)	50	75	50	75
Insertion Loss (dB)	7 max	0.7 max	1 dB + 1.0 max	1 dB + 1.0 max
Accuracy (dB)	±0.5 to 500 MHz ±1.0 to 1000 MHz ±3.0 to 2000 MHz	±0.5 to 500 MHz ±1.0 to 1000 MHz	±1.0 to 400 MHz ±2.0 to 1000 MHz	±1.0 to 500 MHz ±2.0 to 1000 MHz
VSWR	1.2 to 1000 MHz 1.5 to 2000 MHz	1.1 to 500 MHz 1.2 to 1000 MHz	1.2 to 400 MHz 1.4 to 1000 MHz	1.2 to 500 MHz 1.3 to 1000 MHz
Max Input Power	½W	½W	½W	½W
Angle Between Steps	30° from 0 to 10 dB 45° from 0 to 70 dB	30° from 0 to 10 dB 45° from 0 to 70 dB	—	
Connectors	BNC Female (SMA, TNC and N available)	BNC Female (F available)	BNC Female (SMA, TNC and N available)	BNC Female (F available)
PRICE (FOB Beech Grove)	$265	$265	$465	$465

NOTE All accuracy is with reference to the minimum loss position
**7580.1A has dc blocks in both input and output*

MICROWAVE SIGNAL GENERATOR SELECTION GUIDE

MODEL	904	907	907A	952	954	955	957
Frequency Range (GHz)	3.7 to 7.6	7.0 to 11.0	7.0 to 12.4	1.0 to 4.0	3.7 to 7.6	7.5 to 12 4	12.0 to 18.0
Frequency Accuracy	± 1.0%						
Maximum Output: Unleveled	+ 3 dBm, typ	+ 3 dBm	+ 3 dBm,typ	+ 10 dBm	+ 7 dBm		
Leveled	0 dBm						
Attenuation Range	>127 dB, Calibrated			>25 dB			
Amplitude Display Resolution	0.1 dB						
Amplitude Accuracy	± 1 0 dB*						
Flatness	± 1.0 dB						
Residual FM, Peak	<5 kHz	<15 kHz		<8 kHz	<15 kHz		
Harmonics	< – 25 dBc	< – 30 dBc		< – 12 dBc		< – 20 dBc	
AM Modulation: Internal				•	•	•	•
External	•	•	•	•	•	•	•
FM Modulation: Internal & External	•	•	•	•	•	•	•
Pulse Modulation	•	•	•				
External Amplitude Control	•	•	•				
Optional GPIB	•		•				
Featured on Catalog Page	130	130, 132	130, 133	134	134	134	134

NOTE: All units also include 10 MHz display resolution, < – 55 dBc spurious, and external frequency control. *See detailed specifications for calibrated amplitude accuracy.

MICROWAVE SWEEP GENERATOR SELECTION GUIDE

MODEL	2002B	2005	962	964	965	967
Frequency Range (GHz)	0.001 to 2.5	0.001 to 4.5	1.0 to 4.0	3 7 to 8.4	7.0 to 12.4	12 0 to 18 0
Frequency Accuracy	50 MHz*	100 MHz*	± 1%			
Display Resolution	10 to 50 MHz	10 to 100 MHz	10 MHz			
Maximum Output: Leveled	> + 13 dBm		> + 10 dBm			
Unleveled	> + 13 dBm		> + 12 dBm			
RF Level Control Range	90 dB	70 dB	>25 dB			
Leveled Output Flatness	< ± 0.5 dB	< ± 0.75 dB	< ± 1.0 dB**			
Residual FM, Peak	<20 kHz		<8 kHz	<15 kHz	<20 kHz	<25 kHz
Harmonics	< – 30 dBc	< – 26 dBc	< – 12 dBc	< – 20 dBc		
Spurious	< – 35 dBc	< – 50 dBc	< – 55 dBc			
Sweep Modes: CW, ΔF, Start/Stop	•	•	•	•	•	•
No. of Markers: Independent	5 Optional		3			
Harmonics	1, 10, 50, 100 MHz	1, 10, 50, 100, 500 MHz				
Marker Type: RF PIP, CRT Z-Axis	•	•	•	•	•	•
Sweep Trigger	Auto, External, Manual, Line		Auto, External			
Optional GPIB	•	•				
Featured on Catalog Page	138	138	140	140	140	140

NOTE: All units also include external AM/FM and various analog controls. See detailed specifications

***See detailed specifications**
****Optional internal leveling**

SELECTION GUIDE — SCALAR ANALYZERS & POWER METERS

SCALAR ANALYZER SELECTION GUIDE

MODEL	1038-HV	1038-N10	1038-NS20
Frequency	100 kHz to >100 GHz		10 MHz to 40 GHz
Accuracy	0.1 dB/10 dB	0.2 dB*	
Dynamic Range	60 dB	76 dB	
Balanced Detectors		•	•
Digital Refresh CRT	•	•	•
Normalizing Memory Per Channel	1024 Points	2048 Points	
Channels	1, 2 or 3	3	2
Internal Reference Channel			•
Calibrator	•	•	•
GPIB Option	•	•	•
X-Y Recorder Output	•	•	•
Auto-zero		•	•
Zoom-in Mode		•	•
Rack Mount Option	•	•	•
Use with any Sweeper	•	•	
Integrated Sweeper			•
Extension Cables	•	•	•
Catalog Page	150	148	144

*Dependent on power level

POWER METER SELECTION GUIDE

MODEL	1034A	1018B	1045	8500
CW Power	−50 to +10 dBm	−20 to +10 dBm	−50 to +10 dBm	−40 to +20 dBm
Peak Power		20 to +20 dBm		−20 to +20 dBm
Frequency	1 MHz to 18 GHz	100 MHz to 26.5 GHz	1 MHz to 26.5 GHz	30 MHz to 40 GHz
No. of Detectors	1		1 to 4	1 or 2
Basic Accuracy*	0.2 dB	0.2 dB	0.1 dB	0 09 dB
Calibrator	•	•	•	•
Self-calibrating Detector Tracking				•
Trigger (Internal/ External)		•	•	•
Min Pulse Width	CW	200 ns	CW	15 ns
Graph Mode				•
Balanced Detectors				•
Cal Factor	Manual (Knob)			Automatic (ROM)
GPIB		Optional		Standard
MATE Option				•
Delay Accuracy		2μs		0.01% +1 ns
Analog Output	•	•	•	•
Menu Driven				•
Display Setups				9
Battery Option	•			
Catalog Page	155	154	155	152

*Dependent on power level

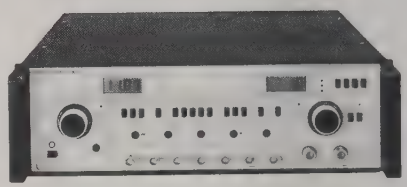
3.7 to 12.4 GHz Signal Generators

- 0 to −127 dBm Output Control
- All Solid State Construction
- 80 dB Pulse On/Off Ratio
- Internal Frequency Sweep
- Optional GPIB Programming

All Solid State Construction
Wavetek's Model 900 Series Microwave Signal Generators feature 100% solid state construction and all the capabilities of traditional signal generators. Remote analog control of frequency and output level, internal full-band sweep and optional GPIB control further enhance their usefulness for many applications.

High Performance
Efficient RF power level control is provided by a single control knob with digital display and automatic internal power leveling. Power level accuracy is enhanced by a modern design which includes digital power correction. The electronic output attenuator will never wear out, even after continuous power cycling under computer control. Excellent pulse modulation characteristics meet the needs of modern radar systems, while AM and FM provide versatility with a minimum of additional test equipment.

Optional GPIB Programming
The optional General Purpose Interface Bus (GPIB) programming is fully compatible with the IEEE Standard 488-1978. This option is ideal for high volume testing and applications which require remote control.



Model 907

Model 907 differs from Models 904 and 907A in that it does not provide for internal sweep or optional GPIB control and its colors remain the original Wavetek black and white. The 907 has been assigned National Stock Number 6625-01-091-8459 by the U.S. Air Force.

3.7–7.6 GHz

VERSATILITY

A cw signal source with AM, FM, pulse modulation, and sweep capabilities. All parameters are independently adjustable.

Pulse modulation, frequency modulation and sweep ramp signals all originate from either the internal modulation generator or external input.

Frequency and level can be externally controlled by analog voltages or optional GPIB.

Auxiliary output and internal modulator signals are available at the front panel.

Modes

CW: Continuous RF output. Frequency and level adjustable.

FM: Internal or external signal frequency modulates the RF output. Rate and deviation adjustable.

Pulse: Internal or external signal pulse modulates the RF output.

Pulse width adjustable or fixed 50% duty cycle; rate adjustable. External gate mode allows the external input to control pulse width and repetition rate.

Sweep: Internal or external controlled sweep (up to 15 Hz rate) of the entire RF frequency range.

OUTPUT

NOTE: Specifications for non-sweep modes only.

Frequency

Varied by a 10-turn potentiometer and vernier or by an external 0 to +5V. GPIB control optional.

Range: 3.7 to 7.6 GHz.

Readout: 3 digit LCD.

Resolution: 10 MHz.

Accuracy: ±1% of reading.

Stability: Typically <60 ppm/°C and 20 ppm (+5, −10% line variation).

Signal Purity

Residual FM: <5 kHz peak in a post-detection bandwidth of 100 Hz to 10 kHz (3 kHz peak typical).

Harmonics: <−25 dBc.

Spurious: <−55 dBc.

Level

Varied by a 10-turn potentiometer or external 0 to +13.6V (−10 dB/V). Output can be unleveled or automatically leveled. Output can be switched on and off. GPIB control optional.

Range (Leveled): 0 to −127 dBm; 0.225V to 0.100 μV (into 50Ω).

Range (Unleveled): Typically >+3 to <−115 dBm.

Readout: 3½ digit LCD, in units of dBm, dBref, Vrms.

Display Resolution: 0.1 dB.

Amplitude Accuracy:

Accuracy	Range
±1 dB (typ ±0.5)	0 dBm
±2 dB	+1 to −100 dBm
±3 dB	−100 to −120 dBm

Leveled power to approximately −127 dBm.

Level Flatness (>−10 dBm): ±1.0 dB

VSWR: <1.5 relative to 50Ω.

Connector: Female type N coax.

Auxiliary Output:

Typically >−10 dBm CW.

Reverse Power Protection:

+30 dBm (both RF outputs).

Frequency Sweep

Internal: Pushbutton gives full band sweep; rate adjustable.

Rate Range: 0.02 to 15 Hz.

External: Control with ramp input. 0 to +5V for full band sweep.

Sweep Range: 3.7 to 7.6 GHz.

Rate Range: Up to 15 Hz.

Frequency Control Monitor: Output voltage (0 to +10V nominal) proportional to RF frequency control signal. 600Ω source impedance.

Pen Lift (TTL): Selective polarity output pulse.

PULSE MODULATION

Transition Times: <20 ns for leading and trailing edges. (Typically 10 ns).

On-Off Ratio: >80 dB when main output is set at 0 dBm.

Width: 50 ns to 500 μs in 2 ranges; for greater widths, use external gated mode.

Delay Range: 100 ns to 1 ms in 2 ranges, relative to normal sync. (Not applicable to gated pulse).

Internal Mode: Fixed square wave or variable width pulses; 10 Hz to 10 kHz in 3 ranges.

External Trigger Input: 1 Vp-p min, ±10V max trigger; slope and trigger point adjustable; 0 to 10 kHz with full leveling.

External Gate Mode: RF output occurs for the duration that pulse trigger input signal exceeds trigger level setting; 0 to 10 kHz with full leveling.

FM—FREQUENCY MODULATION

Internal Sawtooth Modulator: 10 Hz to 10 kHz in 3 ranges; 0 to >5 MHz p-p deviation.

External Modulation: >1 MHz/V; ±2.5V max; >5 MHz p-p deviation; 10 kΩ nominal input impedance.

Bandwidth: >10 kHz (DC coupled).

AM—AMPLITUDE MODULATION

Bandwidth: >10 kHz (DC coupled).

Max Source Level: ±2V peak.

Sensitivity: 27 dB/V (nominal).

Input Impedance: 10 kΩ nominal.

MODULATOR OUTPUTS

FM: Signal from external or internal modulation generator. 600Ω source impedance.

Pulse: Positive TTL level pulse set by modulator pulse repetition rate, delay, and width controls.

Normal Sync: Positive TTL level pulse occurring at selected repetition rate.

Delayed Sync: Positive TTL level pulse synchronous with modulator pulse with selected delay.

GENERAL

Literature

Refer to Models 904/907A Summary Brochure #900-10 and Technical Information Brochure #900-20 for more complete performance characteristics and instrument descriptions.

Environment

Specifications apply for 25° ±10°C after 1 hour warm-up. Instrument operates from 0°C to +50°C, to 10,000 ft and to 90% rel humidity, non-condensing. Storage: −25°C to +65°C. Designed and type tested to MIL-T-28800 class V.

Dimensions (Max)

43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 49.5 cm (19½ in.) deep. Adapters supplied for rack mounting.

Weight

19.5 kg (43 lb) net; 23.2 kg (51 lb) shipping.

Power

100V, 120V, 220V, 240V (+5%, −10%); 48 to 66 Hz; <100 VA.

OPTIONS

001: GPIB Programming

General Purpose Interface Bus (GPIB) programming fully compatible with the IEEE Standard 488-1978. Allows programming of frequency, level, CW, output on/off and leveled/unleveled

NOTE: Option requires factory installation
Option price applies to original purchase only
Contact factory for retrofit option price

FACTORY/FOB

San Diego, CA

PRICE

Model 904	**$10250**
Option 001	**$1500**

7-11 GHz

VERSATILITY

A cw signal source with AM, FM, pulse modulation and external sweep capabilities. All parameters are independently adjustable.

Pulse and FM modulation signals externally provided or from the internal modulation generator.

Frequency and output level can be externally controlled by analog voltages.

Internal modulator signals available for monitoring and system synchronization.

Modes

CW: Continuous RF output. Frequency and level adjustable.

FM: Internal or external signal frequency modulates the RF output. Rate and deviation adjustable.

Pulse: Internal or external signal pulse modulates the RF output.

Pulse width adjustable or fixed 50% duty cycle; rate and delay adjustable. External pulse mode triggers on rising or falling edge of input signal. A gate mode allows the external input to control pulse width and repetition rate.

OUTPUT

Frequency

Varied by a 10-turn potentiometer and a 0.1% vernier or by an external 0 to +5V.

Range: 7.0 to 11.0 GHz.

Readout: 3½ digit LCD.

Resolution: 10 MHz.

Accuracy: ±1% of reading.

Stability: Typically <60 ppm/°C; <20 ppm (±10% line variation).

Signal Purity

Residual FM: <15 kHz peak in a post-detection bandwidth of 100 Hz to 10 kHz.

Harmonics: <−30 dBc.

Spurious: <−55 dBc.

Level

Varied by a 10-turn potentiometer or external 0 to +13.6V (−10 dB/V). Output can be switched on and off.

Range (Leveled): 0 to −127 dBm; 0.225V to 0.100 μV (into 50Ω).

Maximum Output: Typically >+3 dBm unleveled.

Readout: 3½ digit LCD, in units of dBm, dBref, Vrms.

Display Resolution: 0.1 dBm.

Amplitude Accuracy:

Accuracy	Range
±1 dB	0 dBm
±2 dB	0 to −60 dBm
±3 dB	−60 to −127 dBm

Level Flatness: (>−10 dBm: ±1.0 dB.

VSWR: <1.5 relative to 50Ω

Connector: Female type N coax.

Auxiliary Output Power: Typically >−10 dBm CW signal.

Reverse power protection: +30 dBm (both RF outputs)

PULSE MODULATION

Transition Times: <35 ns for leading and trailing edges. (Typically <15 ns).

On-Off Ratio: >80 dB when main output is set at 0 dBm.

Width: 200 ns to 100 μs in 2 ranges; for greater widths, use external gate mode.

Delay Range: 3 μs to 1 ms in 2 ranges, relative to normal sync. (Not applicable to gate mode).

Internal Mode: Fixed square wave or variable width pulses; 10 Hz 50 10 kHz in 3 ranges.

External Pulse Mode: Triggers internally generated pulse delay and width from PULSE TRIG input.

External Trigger Input: 1 Vp-p min. trigger, ±10V max trigger; slope and trigger point adjustable; 0 to 10 kHz with full leveling.

External Gate Mode: RF output occurs for the duration that pulse trigger input signal exceeds trigger level setting; 0 to 10 kHz with full leveling.

FM-FREQUENCY MODULATION

Max RF Output Deviation: >5 MHz p-p

Internal Sawtooth Modulator: 10 Hz to 10 kHz in 3 ranges.

External Modulation: >1 MHz/V; ±2.5V max; 0 to >10 kHz; 10 kΩ nominal input impedance.

AM-AMPLITUDE MODULATION

Ext. Modulation Frequency Range: 0 to 10 kHz.

Max. Source Level: ±2V peak.

Input Impedance: 10 kΩ nominal.

Sensitivity: 27 dB/V (nominal).

MODULATOR OUTPUTS

FM: Signal from external or internal modulation generator. 600Ω source impedance.

Pulse: Positive TTL level pulse set by modulator pulse repetition rate, delay and width controls.

Normal Sync: Positive TTL level pulse occurring at selected repetition rate.

Delayed Sync: Positive TTL level pulse synchronous with modulator pulse with selected delay.

GENERAL

National Stock Number

Equivalent to NSN6625-01-091-8459 with minor differences.

Environment

Specifications apply for 25° ±10°C after 1 hour warm-up. Instrument will operate from 0°C to +50°C, to 10,000 ft altitude and to 90% relative humidity non-condensing. Storage: −25°C to +65°C. Designed and type tested to MIL-T-28800 class V.

Dimensions (Max)

43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 49.5 cm (19.5 in.) deep. Rack adapters supplied for rack mounting.

Weight

19.1 kg (42 lb) net; 22.3 kg (49 lb) shipping.

Power

90 to 105V, 108 to 126V, 198 to 231V; 50 to 400 Hz; 140 VA maximum.

FACTORY/FOB

San Diego, CA

PRICE

Model 907	**$9950**

7-12.4 GHz

VERSATILITY

A cw signal source with AM, FM, pulse modulation and sweep capabilities. All parameters are independently adjustable.

Pulse modulation, frequency modulation, and sweep ramp signals from either the internal modulation generator or external input.

Frequency and level can be externally controlled by analog voltages or optional GPIB.

Auxiliary output and internal modulator signals are available at the front panel.

Modes

CW: Continuous RF output. Frequency and level adjustable.

FM: Internal or external signal frequency modulates the RF output. Rate and deviation adjustable.

Pulse: Internal or external signal pulse modulates the RF output. Pulse width adjustable or fixed 50% duty cycle; rate adjustable. External gate mode allows the external input to control pulse width and repetition rate.

Sweep: Internal or external controlled sweep (up to 15 Hz rate) of the entire RF frequency range.

OUTPUT

NOTE: Specifications for non-sweep modes only.

Frequency

Varied by a 10-turn potentiometer and vernier or by an external 0 to +5V. GPIB control optional.

Range: 7.0 to 12.4 GHz.

Readout: 3½ digit LCD.

Resolution: 10 MHz.

Accuracy: ±1% of reading.

Stability: Typically <60 ppm/°C; <20 ppm (+5%, −10% line variation).

Signal Purity

Residual FM: <15 kHz peak in a post-detection bandwidth of 100 Hz to 10 kHz.

Harmonics: −30 dBc.

Spurious: −55 dBc.

Level

Varied by a 10-turn potentiometer or external 0 to +13.6V (−10 dB/V). Output can be unleveled or automatically leveled. Output can be switched on and off. GPIB control optional.

Range (Leveled): 0 to −127 dBm; 0.251V to 0.100 μV (into 50Ω).

Range (Unleveled): Typically >+3 to <−115 dBm.

Readout: 3½ digit LCD, calibrated in dBm, dBref, Vrms.

Display Resolution: 0.1 dB.

Amplitude Accuracy:

Accuracy	Range
±1 dB (typ ±0.5)	0 dBm
±2 dB	+1 to −60 dBm
±3 dB	−60 to −120 dBm

Leveled power to approximately −127 dBm.

Level Flatness (>−10 dBm): ±1.0 dB.

VSWR: <1.5 relative to 50Ω.

Connector: Female type N coax.

Auxiliary Output: Typically >−10 dBm.

Reverse power protection: +30 dBm (both RF outputs).

Frequency Sweep

Internal: Pushbutton gives full band sweep; rate adjustable.

Rate Range: 0.02 to 15 Hz.

External: Control with ramp input. 0 to +5V for full band sweep.

Sweep Range: 7 to 12.4 GHz.

Rate Range: Up to 15 Hz.

Frequency Control Monitor: Output voltage (0 to +10V nominal) proportional to RF frequency control signal. 600Ω source impedance.

Pen Lift (TTL): Selective polarity output pulse.

PULSE MODULATION

Transition Times: <35 ns for leading and trailing edges. (Typically <15 ns).

On-Off Ratio: >80 dB when main output is set at 0 dBm.

Width: 200 ns to 100 μs in 2 ranges; for greater widths, use external gated mode.

Delay Range: 3 μs to 1 ms in 2 ranges, relative to normal sync.

(Not aplicable to gated pulse).

Internal Mode: Fixed square wave or variable width pulses; 10 Hz to 10 kHz in 3 ranges.

External Trigger Input: 1 Vrms min, 10 Vrms max trigger; slope and trigger point adjustable; 0 to 10 kHz with full leveling.

Externally Gated Pulse: RF output occurs for the duration that pulse trigger input signal exceeds trigger level setting; 0 to 10 kHz with full leveling.

FM-FREQUENCY MODULATION

Internal Sawtooth Modulator: 10 Hz to 10 kHz in 3 ranges; 0 to >5 MHz p-p deviation.

External Modulation: >1 MHz/V; ±2.5V max; >5 MHz p-p deviation; 10 kΩ nominal input impedance.

Bandwidth: >10 kHz, (dc coupled).

AM-AMPLITUDE MODULATION

Bandwidth: >10 kHz (dc coupled).

Max Source Level: ±2V peak.

Sensitivity: 27 dB/V (nominal).

Input Impedance: 10 kΩ nominal.

MODULATOR OUTPUTS

FM: Signal from external or internal modulation generator. 600Ω source impedance.

Pulse: Positive TTL level pulse set by modulator pulse repetition rate, delay and width pulse controls.

Normal Sync: Positive TTL level pulse occurring at selected repetition rate.

Delayed Sync: Positive TTL level pulse synchronous with modulator pulse with selected delay.

GENERAL

Literature

Refer to Models 904/907A Summary Brochure #900-10 and Technical Information Brochure #900-20 for more complete performance characteristics and instrument descriptions.

Environment

Specifications apply for 25° ±10°C after 1 hour warm-up. Instrument will operate from 0°C to +50°C, to 10,000 ft and to 90% rel humidity non-condensing. Storage: −25°C to +65°C. Designed and type tested to MIL-T-28800 class V.

Dimensions (Max)

43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 49.5 cm (19.5 in.) deep. Adapters supplied for rack mounting.

Weight

19.1 kg (42 lb) net; 22.7 kg (50 lb) shipping.

Power

100V, 120V, 220V, 240 (+5%, −10%); 48 to 66 Hz; 130 VA max.

OPTION

001: GPIB Programming

General Purpose Interface Bus (GPIB) programming fully compatible with the IEEE Standard 488-1978. Allows programming of frequency, level, CW, output on/off and leveled/unleveled

NOTE: Option requres factory installation. Option price applies to original purchase only. Contact factory for retrofit option price

FACTORY/FOB

San Diego, CA

PRICE

Model 907A	**$10450**
Option 001	**$1500**

1 to 18 GHz Micro Sources

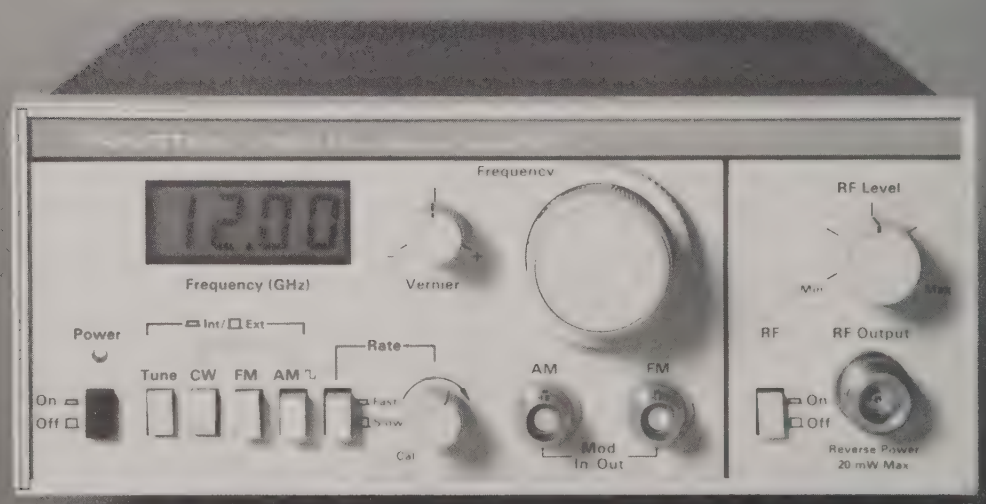
- **1 to 18 GHz From 4 Models**
- **CW, AM, FM and Internal Sweep**
- **+10 dBm Typical Output Power**
- **External Leveling Capability**
- **Compact, Portable and Exceptional Value**

Versatile Performance
The Wavetek Model 950 Micro Sources are exceptional values in compact and modern packages. The four models cover the following frequency ranges.

Model	Range
952	1.0 to 4.0 GHz
954	3.7 to 7.6 GHz
955	7.5 to 12.4 GHz
957	12.0 to 18.0 GHz

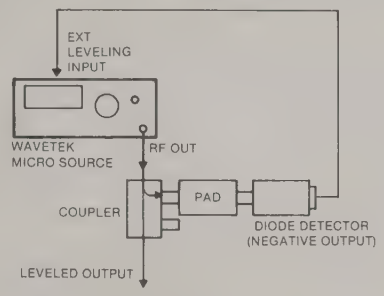
Each Micro Source uses a YIG tuned oscillator to generate low noise, stable CW signals. Maximum output power is typically greater than +10 dBm, with over 25 dB of power control range. In addition to CW, each source provides internal AM, FM and frequency sweep. For greater versatility, both frequency and power level are externally controllable, and all units permit convenient external power leveling and phase locking.

Reliability and Value
The Micro Source Series will give long service in the field or in the lab. The solid-state YIG tuned oscillator and rugged aluminum chassis ensure an exceptionally durable and reliable instrument. And, the clean open interior design results in easy maintenance and low life-cycle costs. Each Micro Source is priced approximately equal to a sweeper plug-in (without the mainframe) for superb value.



Frequency Control
The output frequency of each Micro Source is controlled via a front panel 10-turn potentiometer and single-turn vernier, or by an external 0 to +10 V input to the rear panel connector. In addition, the full frequency range may be internally swept at adjustable rates between 0.1 and 50 Hz, and the external tune capability permits full or partial band sweeps. During each of the above operations, the large, easy-to-read LCD display presents the output frequency with resolution of 10 MHz, and a total accuracy of better than ±1%. While in the internal sweep mode, a 0 to +10V output proportional to frequency is provided at the rear panel Ext Tune/Sweep Out connector.

Power Level Control
Output power level is manually controlled over a 25 dB range by the front panel single turn knob, or externally controlled by a DC voltage applied to the AM input connector. External leveling is also permitted via input of a detected signal to the rear panel Ext Level connector.



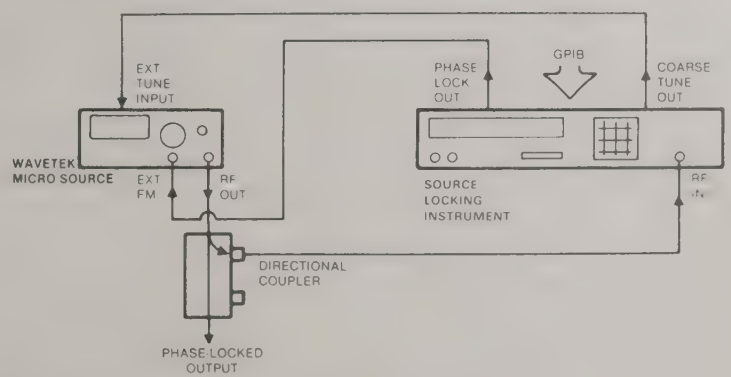
Externally Leveled Power

Also, a front panel RF On/Off switch can completely turn off the internal oscillator without removing power from the rest of the unit.

Internal Modulation
Each Micro Source internally generates both AM (square wave) and FM over a wide range of rates. In conjunction with the Fast/Slow pushbutton, the front panel Rate knob adjusts modulation rates over the 10 to 500 Hz and 100 to 5000 Hz ranges. A CAL detent position also permits quick selection of the commonly used 1 kHz rate. (This knob and pushbutton also control the internal frequency sweep, with rates of 0.1 to 5 Hz and 1 to 50 Hz for the respective Slow and Fast settings.)

External Modulation
External AM and FM are made possible through input to two front panel BNC connectors. In addition, each connector provides a 5V peak-peak output signal for monitoring purposes during internal AM and FM. Each of these two external modulation inputs is DC coupled to allow power control via the AM input and external phase locking through the FM input. Phase locking does not require any adjustments or modifications to the Micro Source. And, with one commonly available source locking counter, phase locked frequency control via GPIB is easily provided over the full frequency range.

Additional Features
Numerous additional features provide increased performance and utility to the user. For instance, during external frequency control, the front panel Fast/Slow button Slow position minimizes residual FM for single frequency operation while the Fast position permits rapid sweep. Only two screws must be removed to lift top or bottom cover and expose all internal components. Also, clever designs provide quick warm-up and good thermal stability.



Phase Locked Operation Under GPIB Control of Frequency

	All Models	Model 952	954	955	957
FREQUENCY					
Range (GHz)		1.0-4.0	3.7-7.6	7.5-12.4	12.0-18.0
Display Resolution	10 MHz				
Accuracy	±1.0% of display (Note 2)				
Stability (Typical)					
With Temperature	0.007% per °C				
With 10% Line Voltage Change	0.001%				
With Time: Short Term	0.002% over 5 min. (Note 3)				
Long Term	0.009% over 1 hr. (Note 3)				
With Load (Mid-band, 3:1 VSWR)	0.1%				
Vernier Tune Range (nominal)		±3 MHz	±4 MHz	±5 MHz	±6 MHz
External Tune	0 to +10V for full range; ±1.0% linearity relative to tuned frequency				
Internal Frequency Sweep	Full band, 0.1 to 50 Hz rate (0 to +10V output proportional to frequency. No markers.)				
OUTPUT POWER					
Maximum Level					
Guaranteed		+10 dBm	+7 dBm	+7 dBm	+7 dBm
Typical	(See Typical Power Output curves.)				
Control Range	25 dB (30 dB typical)				
Output Impedance	50Ω nominal				
Reverse Power Protection	+13 dBm				
External Leveling					
Flatness	±0.1 dB excluding coupler/detector variations (Note 4)				
RF Output Control Range	7 dB nominal				
Input Sensitivity	−50 dB/mV nominal				
Input Impedance	1 kΩ nominal				
SIGNAL PURITY					
Residual FM, Peak (Note 5)					
Guaranteed		8 kHz	15 kHz	15 kHz	15 kHz
Typical		4 kHz	6 kHz	6 kHz	6 kHz
Spurious	−55 dBc				
Harmonics					
Maximum (Note 6)		−12 dBc	−12 dBc	−20 dBc	−20 dBc
Typical		−15 dBc	−15 dBc	−30 dBc	−30 dBc

MODULATION

AM

Internal (Square Wave)	0 to 25 dB depth minimum, 30 dB typical, 10 Hz to 5 kHz adjustable rate.
External	0 to 25 dB depth minimum, 30 dB typical, 0 to ±10V, 100 kHz typical 3 dB bandwidth, DC coupled.
Rise/Fall Time	5μs maximum (10 to 90%).
Monitor Output	TTL compatible, 0 to +5V nominal (during internal modulation only).

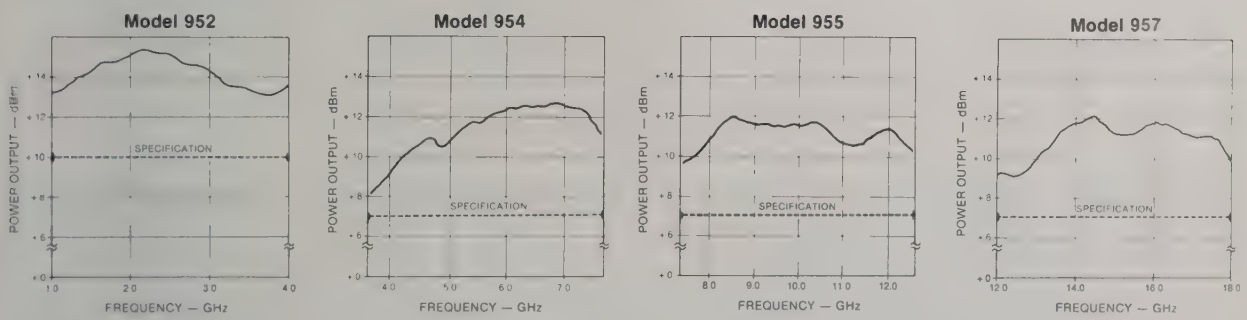
FM

Internal (Sawtooth)	±5 MHz minimum, 10 Hz to 5 kHz adjustable rate.
External	±5 MHz minimum deviation for ±4V input, 50 kHz nominal 3 dB bandwidth, DC coupled.
Monitor Output	5V peak-peak nominal (during internal modulation only).

GENERAL

Connectors	
RF Output	Precision Type N
AC Power	CEE 22 Type VI
Other	BNC
Temperature	
Operating	0°C to +50°C
Non-operating	−40°C to +75°C
Humidity	0 to 95% non-condensing
Dimensions	21.6 cm (8½ in.) wide, 9.8 cm (3½ in.) high, 29.9 cm (11¾ in.) deep.
Weight	5.4 kg (12 lb), approximately
Power	90-126V or 198-252V; 50-400 Hz (50-60 Hz for Model 954); 40VA maximum.

TYPICAL POWER OUTPUT



Notes:

1. All specifications apply after 1 hr warm-up and at 25°C ±10°C unless otherwise stated.
2. Includes all source of error including tuning nonlinearity, temperature, voltage variation, mismatch, etc., with output power set at maximum level. Excludes display resolution.
3. After 1 hr warm-up and 15 min following any frequency change, with environment held constant.
4. At maximum output (using HP 8472A negative polarity detector and 16 dB coupler).
5. 50 Hz to 15 kHz post-detection bandwidth.
6. (This note applies to Model 952 only.) For output power levels of < −10 dBm the harmonic specification is −10 dBc.

FACTORY/FOB

San Diego, CA

PRICE

Model 952	**$5750**
Model 954	**$4950**
Model 955	**$4950**
Model 957	**$5200**

2500 and 4500 MHz Sweepers

- Start/Stop, ΔF and CW Modes
- Analog Programmable
- GPIB Programmable
- Crystal-Controlled Harmonic Markers
- Crystal-Controlled Single Frequency Markers

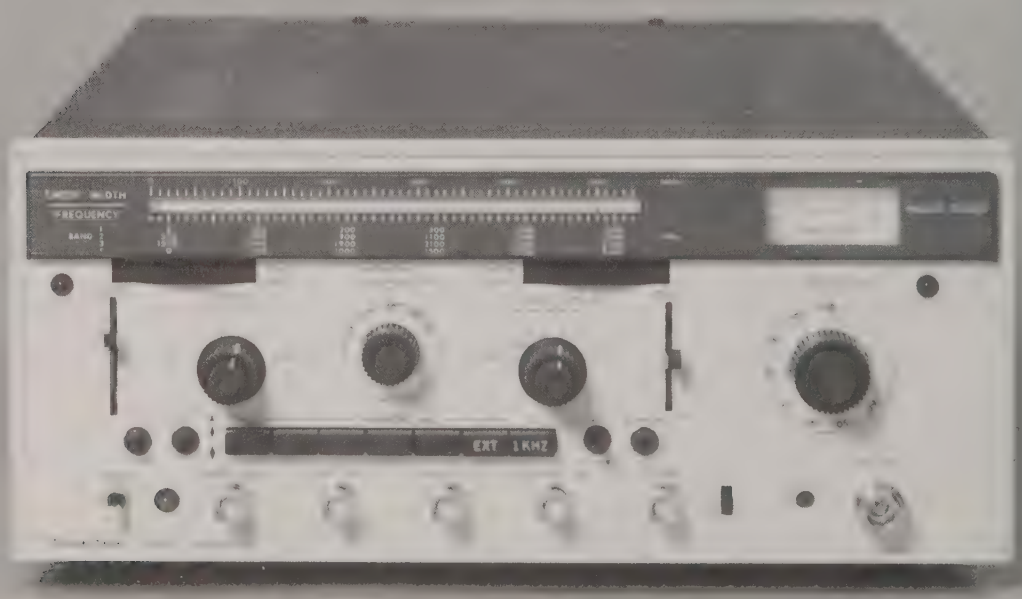
1 to 2500 MHz Range
Model 2002B covers the 1 to 2500 MHz range in three bands: Band 1, a 1 to 500 MHz heterodyne sweep oscillator; band 2, two fundamental oscillators which sweep from 500 to 1000 MHz and 1000 to 1500 MHz, respectively; band 3, a single fundamental oscillator sweeping from 1500 to 2500 MHz. Additionally, all four oscillators may be stacked (sequentially swept) to cover the entire 1 to 2500 MHz instrument range as band 4.

1 MHz to 4.5 GHz Range
Model 2005 has four bands in the same manner as Model 2002B. Band frequencies are: band 1, 1 to 1500 MHz; band 2, 1.5 to 2.5 GHz; band 3, 2.5 to 4.5 GHz; and for band 4, oscillators are stacked to cover the entire 1 MHz to 4.5 GHz frequency range.

Sweep System
Each of the four frequency bands may be used in three modes of operation: start/stop, ΔF or CW. Frequency can be swept over any portion of a given band, in either direction, at any rate from 50 sweeps per second to 1 sweep every 100 seconds. Manual, triggered, or recurring sweeps are also available.

Marker System
Crystal-controlled harmonic markers are at 1, 10, 50, and 100 MHz intervals. Model 2005 has an additional harmonic marker at 500 MHz. Front-panel size and width controls enable optimum adjustment of the marker display. In addition to the standard harmonic markers, there are provisions for the installation of five optional marker modules. These markers may be single-frequency or harmonic type. Each marker has its own front-panel switch.

Remote Operation
The instruments may be remotely controlled by an optional GPIB interface or a standard rear-panel programming connector. Functions controlled are band switching, frequency, sweep width, and output level.



MODELS 2002B & 2005 SWEEP GENERATORS

RF FREQUENCY

Range
Model 2002B:
1 to 2500 MHz in 4 bands:
1 to 500 MHz (band 1);
500 to 1500 MHz (band 2);
1500 to 2500 MHz (band 3);
1 to 2500 MHz (band 4 stacked).
Model 2005:
1 to 4500 MHz in 4 bands:
1 to 1500 MHz (band 1);
1500 to 2500 MHz (band 2);
2500 to 4500 MHz (band 3);
1 to 4500 MHz (band 4 stacked).

Dial Calibration Increments

	Model 2002B	Model 2005
Band 1	10 MHz	30 MHz
Band 2	20 MHz	20 MHz
Band 3	20 MHz	50 MHz
Band 4	50 MHz	100 MHz

CW/Center Frequency Accuracy at 25°C
±1 dial calibration increment.
Sweep Width
ΔF: 200 kHz to 500 MHz.
Start/Stop: 200 kHz to full band.
Display Linearity
1%.
Drift:
(1 hr warm-up at constant temp.)
Model 2002B:
1 to 1500 MHz: <100 kHz/5 min, <2 MHz/8 hr.
1500 to 2500 MHz: <200 kHz/5 min, <4 MHz/8 hr.
Model 2005:
1 to 2500 MHz: <500 kHz/5 min, <4 MHz/8 hr.
2500 to 4500 MHz: <1 MHz/5 min, <10 MHz/8 hr.
Blanking
Controlled by front-panel on/off switch.

CALIBRATED RF OUTPUT

Impedance
50Ω.
SWR
<1.5:1 10 dB attenuation minimum.
RF Output Range
Model 2002B: +13 dBm to −77 dBm.
Model 2005: +13 dBm to −57 dBm.
Attenuation
10 dB steps with 10 dB vernier.

	Step Attenuator	Vernier Attenuator
Model 2002B	70 dB	20 dB
Model 2005	60 dB	11 dB

Attenuator Accuracy
Step: ±0.5 dB or 2% of attenuation.
Vernier: ±0.5 dB (top 11 dB of range).
Output Flatness
Model 2002B: ±0.5 dB.
Model 2005: ±0.75 dB.
Slope Adjustment
Up to ±1 dB/GHz.
Modulation
1 kHz square wave controlled by front panel switch. Ext AM and FM rear panel jack.
Output Connector
Type N.
External Leveling
A negative signal, between 0.2 and 2 V, will level the RF output.

SPECTRAL PURITY

Harmonics
Model 2002B:
1 to 10 MHz: <−20 dBc;
10 to 2500 MHz: <−30 dBc.
Model 2005: (at +13 dBm.)
1 to 2 MHz: <−25 dBc;
2 to 1500 MHz: <−30 dBc;
1500 to 4500 MHz: <−24 dBc.
Nonharmonics
Model 2002B:
1 to 500 MHz: <−35 dBc;
>500 MHz: nondetectable.
Model 2005: (at +13 dBm.)
1 to 1500 MHz <−45 dBc;
>1500 MHz: nondetectable.
Residual FM (CW Mode)
<20 kHz peak to peak.

SWEEP CHARACTERISTICS

Sweep Modes
Repetitive, single, externally triggered, manual and line-locked sweep.
Sweep Time
Continuously variable from 10 ms to 100s, in 4 decade steps, plus vernier.
Horizontal Output
0 to +10 volts. Impedance 10kΩ.

MARKER SYSTEM

RF Markers
1, 10, 50 and 100 MHz harmonic (plus 500 MHz in 2005) and external marker input plus Options A-1 and A-2 (plug-in).
Marker Switches
Individual front-panel on/off switches.
Accuracy
0.005%. Model 2005 at frequencies >2.5 GHz: 0.01%.
Amplitude
Dual sizes: ≈10 mV to 4 Vp-p and ≈50 μV to 25 mVp-p. Internal ratio adjust.
Width
≈15 to 400 kHz. Adjusts in 4 steps.
Marker Tilt
Adjustable from vertical to approx. 90°
External Marker
Ext CW signal ≥100 mV into 50Ω input.
Marker Rectifier Switch
For use with X-Y plotters.

REMOTE PROGRAMMING

GPIB: Options C-2 and C-3.
Analog: ΔF and CW modes, band, level and sweep trigger. Also AM and FM inputs.

EXTERNAL FM

Up to 10 kHz rates, ±50 MHz dev.

EXTERNAL AM

Simultaneous AM and level control.
Frequency Range
DC to 10 kHz (3 dB bandwidth).
Sensitivity
1 Vp-p per 10% AM.
Maximum Modulation %
Level dependent.
Model 2002B: 10 to 90%.
Model 2005: 10 to 50%.

GENERAL

Operating Temperature
25° ± 5°C.
25 ± 15°C with spec degradation.
Dimensions
31.8 cm (12 ½ in.) wide; 13.3 cm (5¼ in.) high; 48.3 cm (19 in.) deep.
Weight
10.5 kg (23 lb) net; 12.7 kg (28 lb) shipping.
Power
100, 120, 220, or 240 Vac ±10%; 45 to 400 Hz, 60 VA maximum

OPTIONS

A-1 **$105**
Single Frequency Marker. Specify frequency.
A-2 **$125**
Harmonic-Type Comb Marker.
1, 5, 10, 50 or 100 MHz. 1 to 1500 MHz range. Specify frequency.
C-2 **$1500**
GPIB: ΔF, S/S, CW modes; band and level
C-3 **$1100**
GPIB: 0 to 70 dB Attenuator

ACCESSORIES

K236 **$55**
Rack Mount

FACTORY/FOB

Beech Grove, IN

PRICE

Model 2002B **$6435**
(Includes 1, 10, 50, 100 MHz Harmonic Markers)
Model 2005 **$8495**
(Includes 1, 10, 50, 100 500 MHz Markers)

1 to 18 GHz Micro Sweep Generators

- **Start/Stop and ΔF Sweep Plus CW**
- **3 Independent Markers**
- **+10 dBm Leveled Power**
- **Smaller Than a Sweeper Plug-in**
- **Very Cost Effective**

The 960s are a series of four microwave sweep generators.

Model	Range
962	1 to 4 GHz
964	3.7 to 8.4 GHz
965	7.0 to 12.4 GHz
967	12.0 to 18.0 GHz

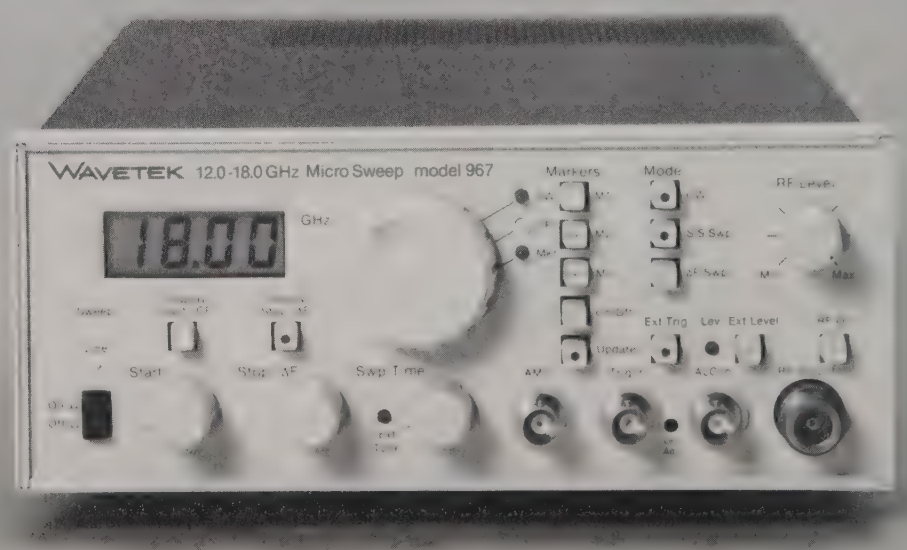
They feature three operating modes (Start/Stop Sweep, ΔF Sweep and CW) plus External Tune/Sweep, and three independently settable markers. CW accuracy is ±1%, and the digital frequency display provides 10 MHz resolution.

Each Micro Sweep is smaller than a typical sweeper plug-in and weighs less than 12 pounds, yet is a fully functional sweep generator.

Every Micro Sweep employs a low noise YIG tuned oscillator to cover one or more full bands within the 1 to 18 GHz range. More than +12 dBm of unleveled output power is available and may be controlled over greater than a 25 dB range. +10 dBm is available while using external leveling or the internal leveling option.

CW, Center Frequency, and Marker frequencies are easily set by the high resolution frequency control knob. Individual controls set the other parameters.

Markers may be set as CRT Z-axis intensity or RF pip markers, or both. Intensity marker and retrace blanking Z-axis output can be set for either a positive or negative CRT intensity control.



Frequency

Range: 1 to 18 GHz; determined by model.

Display Resolution: 10 MHz.

Sweep Functions

Start/Stop Sweep: Sweeps from the frequency set by the Start control to the frequency set by the Stop/ΔF control. Both frequencies are continuously adjustable over full range. Pressing the front panel S/S Swp pushbutton selects the Start/Stop sweep mode. Pushbuttons below LCD readout select the frequency displayed. Minimum practical sweep width is less than 1% of band. Downward sweep is permitted.

ΔF Sweep: Sweeps symmetrically upward, centered on the frequency set by the main tuning knob. Pressing front panel ΔF Swp pushbutton selects the ΔF sweep mode. Sweep width is set by using the Stop/ΔF control. Pushbuttons below the LCD readout select the frequency displayed. Width is adjustable from 100% to less than 1% of the band.

CW Operation: Single frequency RF output is controlled by the main tuning knob. Pressing front panel CW mode pushbutton selects the CW mode. An illuminated LED near the main tuning knob indicates when the knob is functioning as CW, Center Frequency, or Marker Frequency control.

Remote Control: Both frequency and RF level may be remotely controlled. Remote frequency control/sweep is controlled by a 0 to 10V analog signal at the Swp Out/Ext Tune In BNC connector located on the rear panel. To select this mode, turn Swp Time control to full counter clockwise detent position (Ext Tune position), thus illuminating Ext Tune LED and automatically switching control settings to CW mode. The front panel display indicates the tuned frequency. RF output level is remotely controlled by supplying a dc input to AM In BNC connector.

Frequency Markers

Three constant width markers, independently adjustable over the full frequency band of the instrument, are available for all sweep functions: Start/Stop, ΔF, CW and Remote. Intensity (CRT Z axis), amplitude (RF pip) or both marker methods are selected by a switch internal to the unit.

Intensity Marker: A rectangular pulse provides marker signal for Z-axis input to CRT display units. Polarity is factory set for negative, but may be changed to positive via an internal switch. (Retrace blanking signal will be of the opposite polarity.)

Amplitude (RF PIP) Marker: Generated by momentarily reducing the RF output. (Factory set position enables this type of marker. It can be disabled with an internal switch.)

Operation: Marker 1, Marker 2, and Marker 3 are set in any order by first pressing the pushbutton of the desired marker and displaying its frequency at the LCD readout. This activates the marker to accept other commands. The marker is then toggled on/off using the On/Off pushbutton. Marker frequency is changed by pressing the Update pushbutton and then adjusting the main tuning knob. The marker being displayed and operated on is identified by a flashing indicator.

Resolution: Each marker may be set to a digitized resolution of 0.1% of the instrument bandwidth. Display resolution is 10 MHz.

Accuracy: The frequency accuracy of the marker display is typically ±1.0%. (Add ±3 MHz for Model 962.)

Blanking

During retrace, a +5V, nominal, direct coupled rectangular pulse provides the Z-axis input to the CRT display. Polarity may be changed to negative by changing an internal switch. RF blanking is not provided.

Sweep Time

Continuously adjustable from 0.02 to 20 seconds, nominal, per sweep.

Sweep Trigger

Auto-Trigger: Sweep is automatically triggered on a continuous basis.

External Trigger: A single sweep is triggered by a signal at the front panel Trig In BNC. Pressing the Ext Trig pushbutton selects this mode as indicated by an illuminated Ext Trig pushbutton. The sweep is triggered by the falling edge (high to low) of a TTL signal or a switch contract closure to ground. (For longer sweep times, a double pressing of the pushbutton provides a convenient front panel single sweep.)

Sweep Output

During internal sweep, a 0 to +10V direct coupled modified sawtooth waveform is provided at the rear panel Swp Out/Ext Tune In BNC connector. The signal limits are 0V (beginning of the sweep) and +10V (end of the sweep) regardless of sweep width, rate, or direction. In CW mode, output is proportional to frequency, with linear 0 to +10V, nominal, for full instrument bandwidth.

MODEL 960 SERIES — MICRO SWEEP GENERATORS

	All Models	962	964	965	967
FREQUENCY RANGE (GHz)		1.0-4.0	3.7-8.4	7.0-12.4	12.0-18.0
Accuracy (of absolute frequency) (Note 2)					
CW	±1% (0.5% typical)				
Markers, Center Frequency	±1%, typical				
Start, Stop, ΔF	±2%, typical				
Stability (Typical)					
With Temperature	0.007%/°C (0 to 50°C)				
With 10% Line Voltage Change	0.001%				
With Time: Short Term	0.004% over 5 min. (Note 3)				
With Time: Long Term	0.01% over 1 hr (Note 3)				
With Load (midband 3:1 VSWR)	0.1%				
OUTPUT CHARACTERISTICS					
Maximum Output Power					
Unleveled (without internal leveling option)		+12 dBm	+12 dBm	+12 dBm	+12 dBm
Unleveled (with internal leveling option installed)		+11 dBm	+11 dBm	+11 dBm	+11 dBm
Leveled (via internal leveling option)		+10 dBm	+10 dBm	+10 dBm	+10 dBm
RF Level Control					
Unleveled Operation	25 dB minimum 30 dB typical				
Leveled Operation	7 dB min, 10 dB typ.				
RF Leveling					
Internal Option	Flat ±1.0 dB				
External Leveling (Note 4)	Flat ±0.1 dB max. excluding coupler/detector variation.				
Input Sensitivity	−50 dB/mV nominal. Front panel access for gain adjustment provided.				
Input Impedance	1 kΩ nominal.				
Output Impedance	50 Ω nominal.				
VSWR (with internal leveling option) (Note 5)		<2.5	<1.5	<1.5	<1.5
SPECTRAL PURITY					
Residual FM Peak (Note 6)		8 kHz	15 kHz	20 kHz	25 kHz
Spurious		−55 dBc	−55 dBc	−55 dBc	−55 dBc
Harmonics					
Maximum (Note 7)		−12 dBc	−20 dBc	−20 dBc	−20 dBc

MODULATION

External AM

Depth	0 to 25 dB min. (30 dB typical) for a 0 to −10V input.
Bandwidth	100 kHz typical, 3 dB bandwidth, dc coupled.
Input Impedance	10 kΩ nominal.

External FM

Deviation	±5 MHz min. deviation for ±4V input.
Bandwidth	50 kHz typical, 3 dB bandwidth, dc coupled.
Input Impedance	10 kΩ nominal.

GENERAL

Connectors

RF Output	Precision type N.
AC Power	CEE22 Type VI.
All Others	BNC.

Temperaure

Operating	0 to +50°C.
Non-operating	−40 to +75°C (Rate of temperature change not to exceed 1°/min.)

Humidity 0 to 95% noncondensing.

Dimensions 21.6 cm (8½ in.) wide, 9.8 cm (3½ in.) high, 29.9 cm (11¾ in.) deep.

Weight 5.4 kg (12 lb) nominal.

Power 90-126V or 198-252V; 50-400Hz; 40VA.

OPTIONS

001: Internal Leveling

NOTES:

1. All specifications apply after 1 hr warm-up at 25°C ±10°C unless otherwise stated.
2. Includes all sources of error including tuning nonlinearity, temperature, voltage variation, mismatch, etc., with output power set at maximum level. Excludes display resolution. For 962 marker accuracy, add ±3 MHz.
3. After 1 hr warm-up and 15 min. following any frequency change, with environment held constant.
4. At maximum output (using HP 8472A negative polarity detector and 16 dB coupler).
5. (This note applies to Model 962 only.) Typical performance at maximum output level.
6. 50 Hz to 15 kHz post-detection bandwidth.
7. (This note applies to Model 962 only.) For output power levels of < −10 dBm the harmonic specification is −10 dBc

FACTORY/FOB

San Diego, CA

PRICE

Model 962	**$6500**
Model 964	**$6500**
Model 965	**$6000**
Model 967	**$6300**
Option 962-001	**$600**
Option 964-001	**$600**
Option 965-001	**$700**
Option 967-001	**$800**

Microwave Network Measurement System

- **10 MHz to 40 GHz Frequency Range**
- **+16 dBm to −60 dBm Dynamic Range**
- **Integrated Source and Analyzer**
- **Single Point Microprocessor Control Advantage**

Total Integration
Model 1038-NS20 Network Measurement System offers the highest accuracy and the most automation available from today's technology. The totally integrated design of RF Source and Analyzer permits many advanced features, making the NS20 faster, simpler, and easier to operate than any other system available.

Exceptionally accurate simultaneous or individual transmission, reflection, and ratio measurements can be made in just three easy steps:

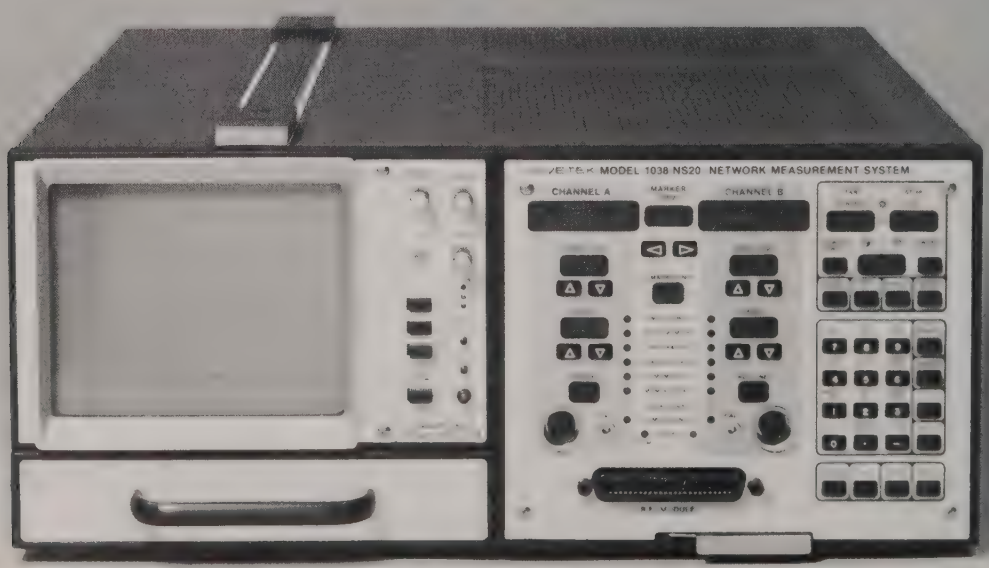
1. Set up equipment and turn it on.
2. Calibrate both channels — seven keys total.
3. Insert the test device and read the data directly from the digital readouts.

Advanced Features/Performance
The 1038-NS20 system has many advanced features that are not available in any other swept frequency system.

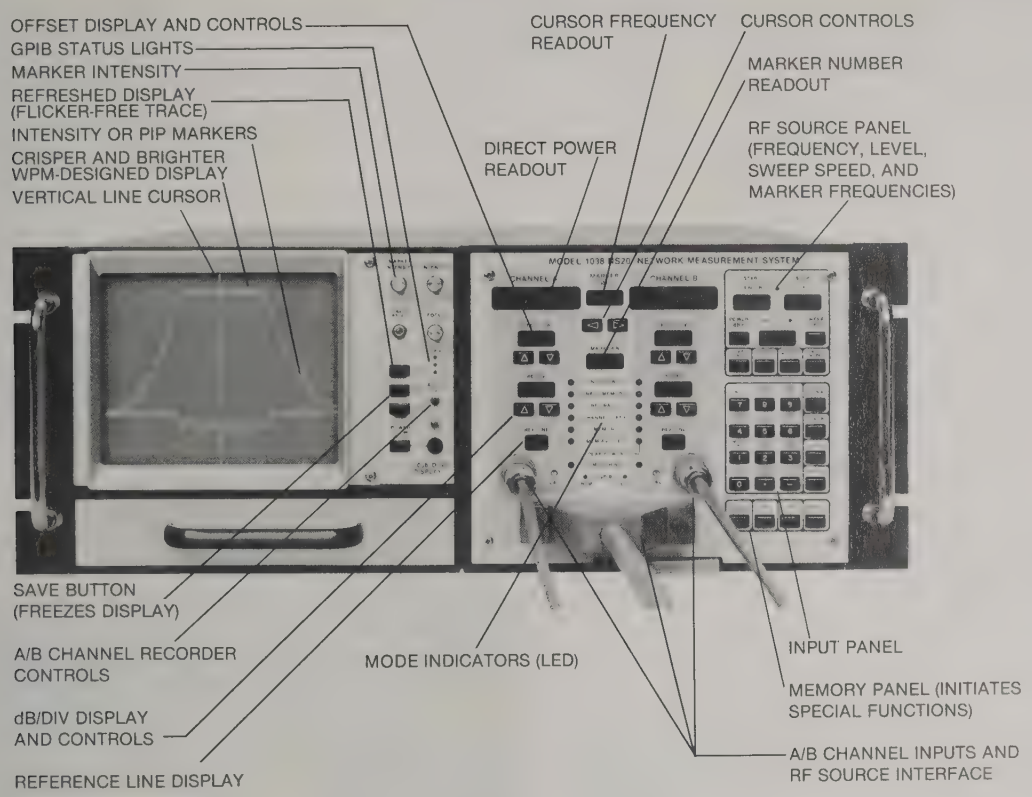
- High performance balanced detectors.
- Adaptive sweep.
- Automatic low-level drift correction.
- Frequency change without recalibration.
- User-definable software programs with unique CREATE mode.
- Special functions allow superior versatility in creating and performing measurement routines.

Versatile Mainframe
Model 1038-D14A Mainframe is standard with all of Wavetek's microwave scalar measurement swept systems, and has the following features:

- X-Y recorder interface through BNC connectors. Both TTL and switch closure logic are available. A calibration signal can be sent to the recorder at the push of a button on the D14A's front panel.
- Full-screen-height vertical cursor for at-a-glance positioning.
- Choice of intensity or pip markers for CRT photos or hardcopy indications, with a separate marker intensity control located on the front of the D14A.



MODEL 1038-NS20 MICROWAVE SCALAR MEASUREMENT SYSTEMS



System Configuration
- 1038-D14A Mainframe (Display)
- 1038-NS20 Analyzer Module
- 1038-NS20X RF Source Module
- Two RF Diode Detectors

RF Source
Four RF Source modules cover the specified frequency range of 10 MHz to 40 GHz. Most modules have built in calibrators and feature both internal and external leveling. Refer to RF Source section for additional information.

Detectors
The patented*, high performance, balanced detectors provide high sensitivity, block low level dc, reduce harmonic effects, and compensate for dc drift. Refer to RF Diode Detector section for additional information.

CRT Display Controls
Five front panel controls can be operated manually or controlled remotely through the GPIB, and consist of:
- Offset controls
- Sensitivity controls
- Reference Line controls
- Cursor controls
- Marker controls

Adaptive Sweep
This feature automatically sets a fast sweep speed at high power levels and a slower speed at low levels, allowing high quality measurements to be taken at levels down to −60 dBm.

Low Level Drift Correction
Low level drift correction is done automatically at the detector input without the need for operator intervention.

Frequency Changes
Frequency changes can be made while testing without the recalibration required with other systems that have less memory.

IEEE BUS Operation
Comprehensive software allows the user to select from extensive menus those parameters that best fit the measurement requirements. The software is not only easy to use, but provides the capability to quickly and easily assemble text programs using Wavetek's unique "LEARN" mode and "CREATE" mode.

Nonvolatile Memory
Nonvolatile memory of the NS20 system will store up to 10 complete test setups for over 30 days after the last turn-off of the system.

Special Functions
In addition to all its other advanced features, the versatile NS20 also has 32 different special functions available. Functions such as a SELF TEST that automatically checks the analog circuitry, and CHANNEL MONITORING to allow the measurement of maximum and minimum power levels between assigned markers are just two of those available.

*US Patent 4,360,865—1982

MODEL 1038-NS20 MICROWAVE SCALAR MEASUREMENT SYSTEMS

SPECIFICATIONS

Frequency
10 MHz to 40 GHz with various wide band source models. (Refer to RF Source section)

Dynamic Range
76 dB (+16 to −60 dBm) measurement range will depend on the power available from the selected RF Source module.

Data Resolution
D14A Mainframe Refresh Memory has 512 points horizontally, and 1024 points vertically for both channels A and B. NS20 Normalizing Memory has 2048 points per channel horizontally with a resolution of 0.006 dB for channel B and 0.04 dB for channel A. Data from the CRT display or LED displays can be manually read out after cursor positioning. CRT display resolution is 0.02 dB on channel A and 0.01 dB on channel B. LED readout resolution is 0.1 dB on channel A and 0.01 on channel B. Readout through the IEEE BUS has 0.02 dB resolution.

Measurement Accuracy
Constant accuracy is maintained within the specified temperature ranges due to special circuitry that continuously monitors the detector temperature and compensates the input voltage for any change in temperature. (Refer to RF Diode Detector section for detailed information.)

Environment
Operating: 0° to +50°C
Storage: −40° to +65°C

Design and Construction
To the intent of MIL-T-28800, Classification Type III, Class 5, Style E or F, Color R.

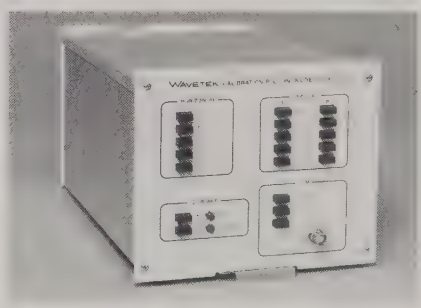
Power
For 1038-D14A Mainframe and 1038-NS20 Analyzer Module — 100, 120, 220, and 240 VAC ±10%; 50 to 400 Hz; 180 VA nominal.

OPTIONS

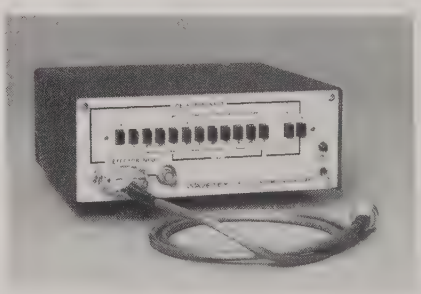
01: Rack Mount Configuration
02: Mainframe Fan Assembly
03: Horizontal Bench Configuration
04: IEEE BUS Interface
05: Vertical Bench Configuration
14: RF Bridge, APC-7 Test Port (201, 206)
15: RF Bridge, APC-3.5(M) Test Port (207)
16: RF Bridge, PAC-3.5(F) Test Port (207)
17: Coupler, 10 dB (202)
19: System Software, HP85
20: System Software, HP9826/36
22: RF Bridge, N(F) Test Port
23: Systems Software, Wavetek Model 6000

ACCESSORIES

The following items are available as accessories to the 1038-NS20 system:



Model C10 Calibration Fixture and Extender Kit
Provides for direct calibration of the D14A Mainframe. It has extension cables and board to permit calibration and maintenance of the NS20.



Power Input Calibration Unit (Detector Simulator)
Provides accurate calibration voltages to the NS20 to allow the amplitude correction circuitry of the NS20 to be quickly and precisely calibrated.

Detector Extension Cables
Each detector is supplied with standard 5 ft cable. 10 ft and 25 ft cables are available from stock. Longer cables on special order.

Adapters
N type 50Ω to WE 75Ω, BNC 75Ω, F 75Ω, or BNC 75Ω thick pin. N type (male) to SMA (female) both 50Ω. RF Bridge Adapter

Viewing Hood

Adapter Cable
For mm Wave Detectors or Autotesters

X-Y Recorder Interface Cables

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 1038-NS20	**$30,600 to 44,250**
Option 01	**$150**
Option 02	**$150**
Option 03	**NC**
Option 04	**$1250**
Option 05	**NC**
Option 14	**$2990**
Option 15	**$3495**
Option 16	**$3570**
Option 17	**$695**
Option 19	**$1050**
Option 20	**$1150**
Option 22	**$3120**
Option 23	**$495**

RF Systems Source Modules for NS20

The four RF Source Modules currently available for use with the NS20 system cover the four most used frequency bands within the range of 10 MHz to 40 GHz. All of the source modules provide superior technical performance, and most of the modules feature a built-in calibrator and have both internal and external leveling. All modules are available in both bench and rack mount configurations.

SPECIFICATIONS

Specifications are common to all modules.

Temperature Stability
<1 MHz/°C.

Frequency Pulling
<0.1 MHz at 12 dB return loss.

CW/Swept Accuracy
(at 25°C)
NS201 – NS206:
± 20 MHz below 2 GHz.
± 10 MHz ± 0.1% from 2 GHz to 18.5 GHz.
± 10 MHz ± 0.2% from 18.5 GHz to 40 GHz.
NS207:
± 25 MHz below 2 GHz
± 20 MHz ± 0.1% from 2 GHz to 26.5 GHz.

Frequency Variation with Line Voltage Fluctuation
Negligable

Leveling Range
(Not applicable to NS202)
Internal/External: >15 dB range

Spectral Purity
Harmonics: < – 50 dBc (– 35 dBc below 2 GHz)
Spurious: < – 60 dBc
Sub-harmonics: None

External FM and Phase Lock Sensitivity
Approximately 6 MHz/V

Impedance:
(Not applicable NS202.)
50Ω nominal

Calibrator Output
(Not applicable to NS202)
50 MHz ± 1 MHz, 0 dBm ± 0.06 dB.
Type N connector

Environment
Operating: 0° to + 50°C
Storage: – 40° to + 65°C.

OPTIONS

01: Rack Mount for NS201 — NS207
02: APC7 Calibrator Output Connector

FACTORY/FOB

Sunnyvale, CA

PRICE

NS201	**$17,790**
NS202	**$16,450**
NS206	**$22,910**
NS207	**$30,110**
Option 01:	
For NS201, NS202	**$795**
For NS206, NS207	**$195**
Option 02	**$225**

SPECIFICATION DIFFERENCES AMONG MODULES

	NS201	NS202	NS206	NS207
Frequency Range	2-18.5 GHz	26.5-40 GHz	10 MHz-18.5 GHz	10 MHz-26.5 GHz
Output (25° ± 10°C				
Max Leveled Power	>5 dBm	>0 dBm*	>5 dBm	>5 dBm
Residual FM (15 Hz to 15 kHz band)†	<10 kHz peak	<20 kHz peak	<10 kHz peak	<15 kHz peak
Output Match at 50Ω	>15 dB RL <1.42 VSWR	>30 dB RL** <1.07 VSWR	>15 dB RL <1.42 VSWR	>15 dB RL <1.42 VSWR
Built-in Ref Channel	YES	YES	YES	YES
Built-in Calibrator	YES	NO	YES	YES
Physical Dimensions (L × W × H)	368 × 165 × 140 mm	368 × 165 × 140 mm	467 × 426 × 133 mm	467 × 426 × 133 mm
Weight	6.4 kg	5.5 kg	14 kg	15 kg

*Not Leveled—Minimum Power is 0 dBm

**3 dBm above 18 GHz

†Typical Below 2.0 GHz

MODEL 1038-N10 MICROWAVE SCALAR MEASUREMENT SYSTEMS

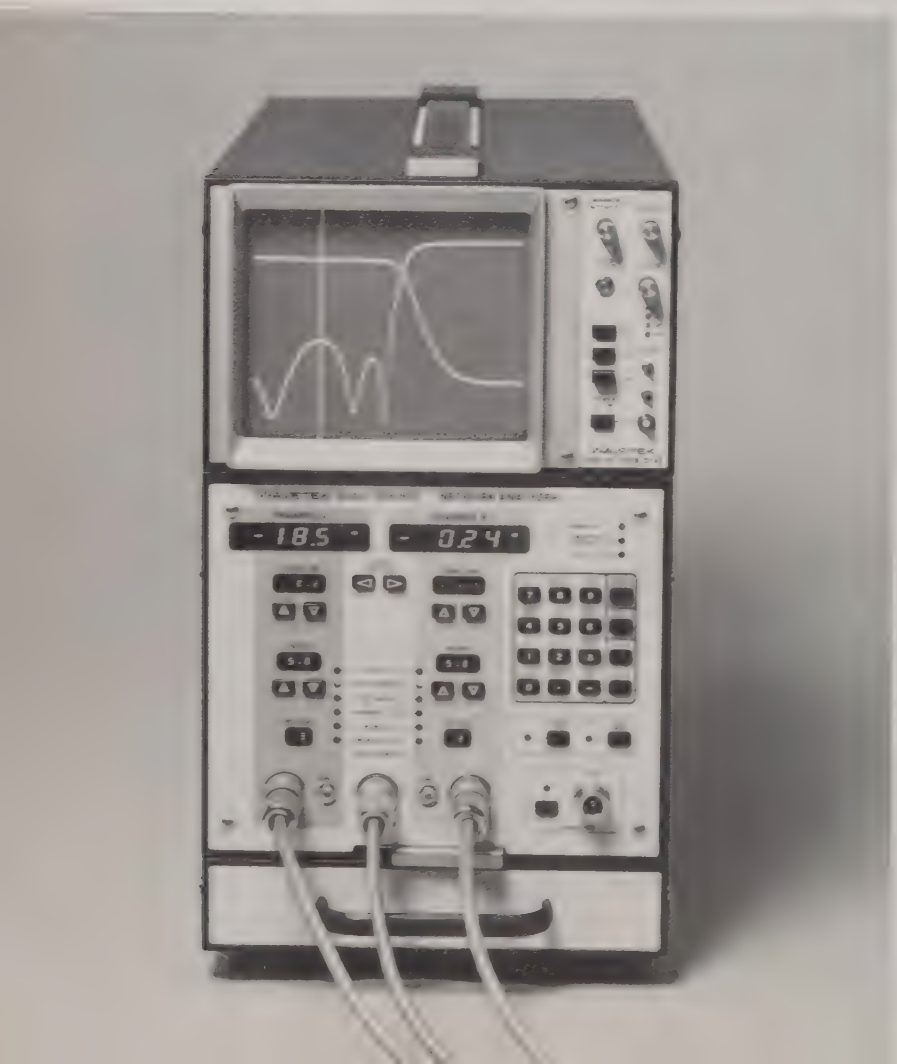
Network Analyzer System

- 76 dB Dynamic Range (+16 to −60 dBm)
- Frequency Range of 100 kHz to >200 GHz
- Direct LED Power Readout
- Change Frequency Limits Without Recalibration
- Use With Any Late Model Sweeper

Model 1038-N10 Network Analyzer System is completely microprocessor controlled and features direct digital readout of power data.

Ease of Operation
Exceptionally accurate simultaneous or individual transmission, reflection, and ratio measurements are made with the N10 system in just three easy steps:

1. Set up equipment and turn it on.
2. Calibrate both channels — seven keys total.
3. Insert test device, and read data directly from digital readouts.



System Configuration
- 1038-D14A Mainframe (Display)
- 1038-N10 Analyzer Module
- Two or three RF Diode Detectors

Versatile Mainframe
Model 1038-D14A Mainframe is standard with all of Wavetek's microwave scalar measurement swept systems. Refer to 1038-NS20 system section for additional mainframe information.

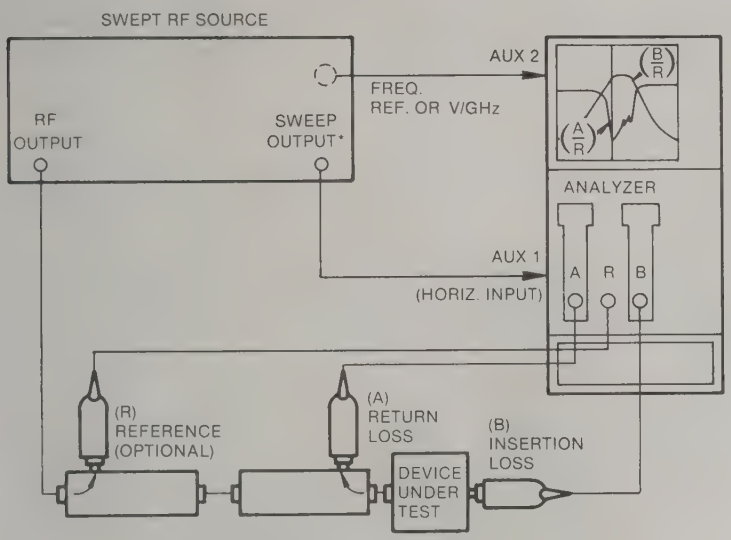
Detectors
The patented*, high performance, balanced detectors provide high sensitivity, block low level DC, reduce harmonic effects, and compensate for DC drift. Refer to RF Diode Detector section for additional information.

Auto Zero Modes
Two Auto Zero modes to ensure drift free low level operation no matter what kind of swept source is used. (Any late model sweeper can be used, and does not have to be bus controlled.) If the sweeper turns off the RF power completely during retrace, the Auto Zero is automatic, or it can be done manually for sweepers that do not turn off the RF.

V∝ F Feature
The V∝F(1V/GHz) feature lets you zoom in on a frequency segment, and then return to the original frequency without losing the memory calibration.

*US Patent 4,360,865—1982

MODEL 1038-N10 MICROWAVE SCALAR MEASUREMENT SYSTEMS



Typical N10 System Return Loss and Insertion Loss/Gain Set-up

Special Functions

Special functions are available that allow you to turn channels on or off, position the cursor, check the health of the unit, sound an audio alarm to signal error or end of test, and to go to a manually controlled sweep mode. These functions are available both through the front panel keypad and through the IEEE bus.

SPECIFICATIONS

Specifications for the 1038-N10 system are the same as for the 1038-NS20 system except for the following:

Frequency
100 kHz to 40 GHz, expandable to above 200 GHz with mm detectors and adapter cable.

Dynamic Range
Balanced Detectors: 76 dB (+16 to −60 dBm).
Waveguide Detectors: 70 dB (+10 to −60 dBm).
Reference Channel: 46 dB (+16 to −30 dBm).

Calibrator
Signal Level: 0 dBm (1 mW) ±0.06 dB.
Frequency: 50 MHz ±2%.
Harmonics: <-50 dBc.
Source Impedance: 50Ω.
Output VSWR: <1.07:1.

Power
For 1038-D14A Mainframe and N10 Analyzer Module: 100, 120, 220, and 240 VAC ±10%; 50 to 440 Hz; 100 VA nominal.

OPTIONS

01: Rack Mount Configuration
02: Mainframe Fan Assembly
03: Horizontal Bench Configuration
04: IEEE BUS Interface
05: Vertical Bench Configuration

ACCESSORIES

The accessories for the 1038-N10 system are the same as for the 1038-NS20 system.

FACTORY/FOB

Sunnyvale, CA

PRICE

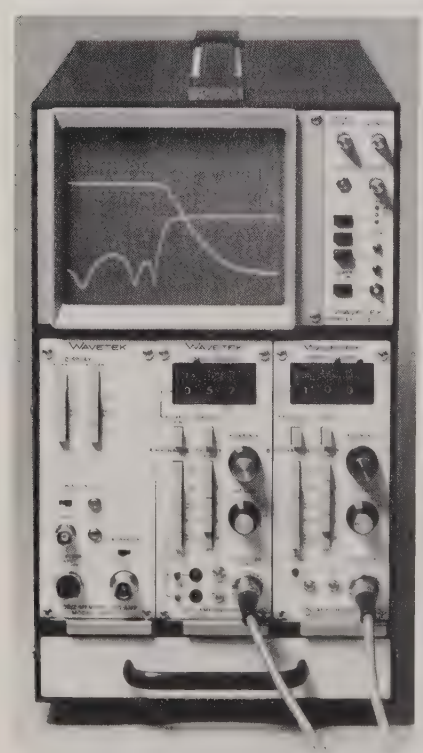
Model 1038-N10	**$11,035**
(Complete System)	**to $12,890**
Option 01	**$150**
Option 02	**$150**
Option 03	**No Charge**
Option 04	**$1250**
Option 05	**No Charge**

MODEL 1038-HV MICROWAVE SCALAR MEASUREMENT SYSTEMS

Swept Frequency Measurement System

- **For Return Loss, Insertion Loss/Gain, & Absolute Power Measurements**
- **Accuracy, Flexibility, & Dependability at Reasonable Cost**
- **Built-in Calibrator & Automatic X-Y Plotting**

For those who don't require all of the features and the functions of the NS20 or N10 systems, the Model 1038-HV Swept Frequency Measurement System is the simple, accurate, and low cost solution for making simultaneous or individual swept transmission, reflection, and absolute power measurements in the 100 kHz to 40 GHz frequency range with Wavetek Pacific Measurements detectors (to over 110 GHz with other mm band detectors).



The 1038-HV system consists of the powerful D14A Mainframe (See Model 1038-NS20 features), and your choice of one horizontal and either one or two vertical signal conditioning plug-ins. Then, selection of either one, two, or three RF detectors allows you to tailor a complete system to your specific needs and budget.

Plug-in Units

Three different horizontal and three different vertical plug-ins are offered to meet your measurement needs:

- **Model H11:** CRT Trace positioning (10-20 Vp-p) detector calibrator.
- **Model H11 Spec 5116:** Same as H11 plus linear ramp output.
- **Model H13:** Same as H11 plus vertical reference channel for comparison with vertical plug-ins.
- **Model V12:** Log and conditioning amplifiers.
  60 dB dynamic range (+10 to −50 dBm).
  Frequency range determined by detector being used.
  1024 point normalizing memory.
- **Model V13:** Same as V12 plus dual memory to allow open/short reflections to be averaged for return loss measurements.
- **Model V20:** Similar to V12 except linear amplification and no detector input.

SPECIFICATIONS

Mainframe
D14A. (See Model 1038-NS20 specifications.)

Coaxial Detectors
Return Loss: 18.0 dB from 2 to 12.4 GHz and 14.0 dB to 26.5 GHz.
Flatness: (Maximum total variation.) With APC3.5 connectors; 1.0 dB from 1 MHz to 18 GHz and 2.0 dB to 26.5 GHz.
With type N or APC7 connectors: 2.0 dB to 18 GHz.
Measurement Accuracy: 0.1 dB/10 dB plus 0.5 dB at −50 dBm.

Waveguide Detectors
(See RF Diode Detectors page.)

Environment
Operating: 0° to 45°C.
Storage: −40° to +65°C.

Design and Construction
To the intent of MIL-T-28800, Classification Type III, Class 5, Style E or F, Color R.

Power
For 1038-D14A Mainframe and Selected Plug-in Modules: 100, 120, 220, and 240 VAC ±10%; 50 to 440 Hz; 100 VA nominal.

OPTIONS

01: Rack Mount Configuration
02: Mainframe Fan Assembly
03: Horizontal Bench Configuration
05: Vertical Bench Configuration

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 1038-HV (Complete System)	**$8490 to $10,315**
Option 01	**$150**
Option 02	**$150**
Option 03	**No Charge**
Option 05	**No Charge**

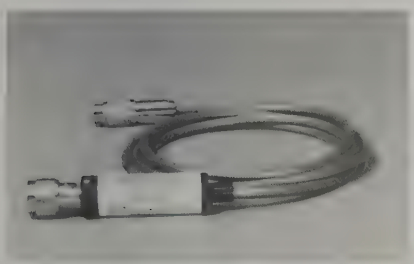
RF Diode Detectors

Wavetek has taken great care to ensure ruggedness and reliability in all of the detectors it produces. Features such as our new internal beads to strengthen the detector element, external plastic housing to reduce thermal shock when handling, thermistors for temperature compensation, networks for linearity compensation, and low pass filters are standard features.

Detector Types

Two types of detectors are provided for use with the NS20 and N10 systems. These are the balanced coaxial models and the balanced element waveguide detector. The coaxial detectors (1 MHz to 18.5 GHz or 1 MHz to 26.5 GHz, useful to 34 GHz) are available with Type N, APC7, and APC3.5 connectors and will handle up to 200 mW (+23 dBm) of continuous CW or peak power. The waveguide detector (26.5 GHz to 40 GHz) has a WR28 waveguide with a UG-599/U flange and will handle up to 100 mW (+20 dBm) of continuous CW or peak power.

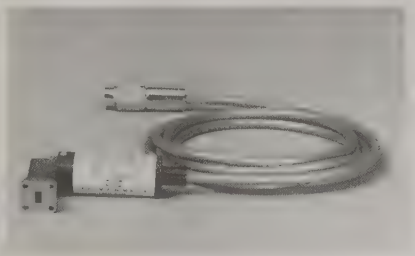
Balanced Detectors



The balanced detectors use two diodes in a patented co-planar full wave circuit. This arrangement provides the following unique features:

- 76 dB dynamic range
- Reduces the effect of even harmonics, thereby increasing measurement accuracy
- Blocks low level dc offset voltages
- Very low thermal drift
- Frequency response of +0.5 dB to -1.0 dB up to 18.5 GHz and +0.5 dB to -1.5 dB up to 26.5 GHz
- Detector accuracy as shown in figure 1
- Return loss as shown in the matrix

Waveguide Detector



The waveguide detector's features are similar to the balanced diode detector's except for the following:

- Frequency response from 26.5 to 40 GHz is flat within ±2.0 dB.
- Detector accuracy is shown in figure 2.
- Return loss shown in matrix.

Literature

Please request Application Note AN23 to obtain full details and comparisons between RF detectors, and to find out why Wavetek Pacific Measurement diode detectors are among the most accurate, reliable, and versatile devices available for measuring RF power at microwave frequencies.

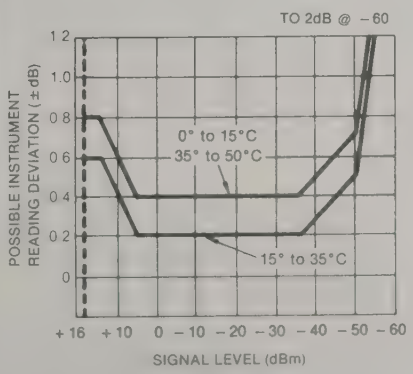


Figure 1. Models 1038-N10 and NS20 System Coaxial Detector Accuracy from 1 MHz to 26.5 GHz.

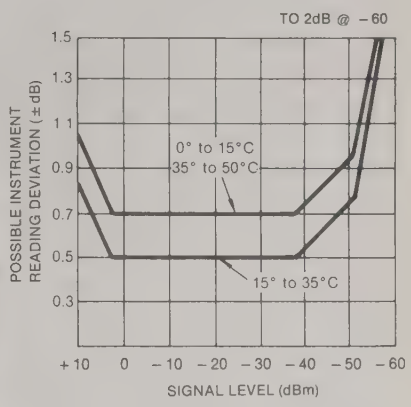


Figure 2. Models 1038-N10 and NS20 System Waveguide Detector Accuracy from 26.5 GHz to 40 GHz

RETURN LOSS (dB)

Frequency	To 2 GHz	To 12.4 GHz	To 18.5 GHz	To 26.5 GHz	To 34 GHz	To 40 GHz
Balanced (any connector below 18.5 GHz. APC 3.5 above 18.5 GHz)	20	18	16	10	—	—
Waveguide	—	—	—	—	10	10

*Typical special order only

FACTORY/FOB

Sunnyvale, CA

PRICE

Contact Sales Representative

Microwave Peak Power Meter

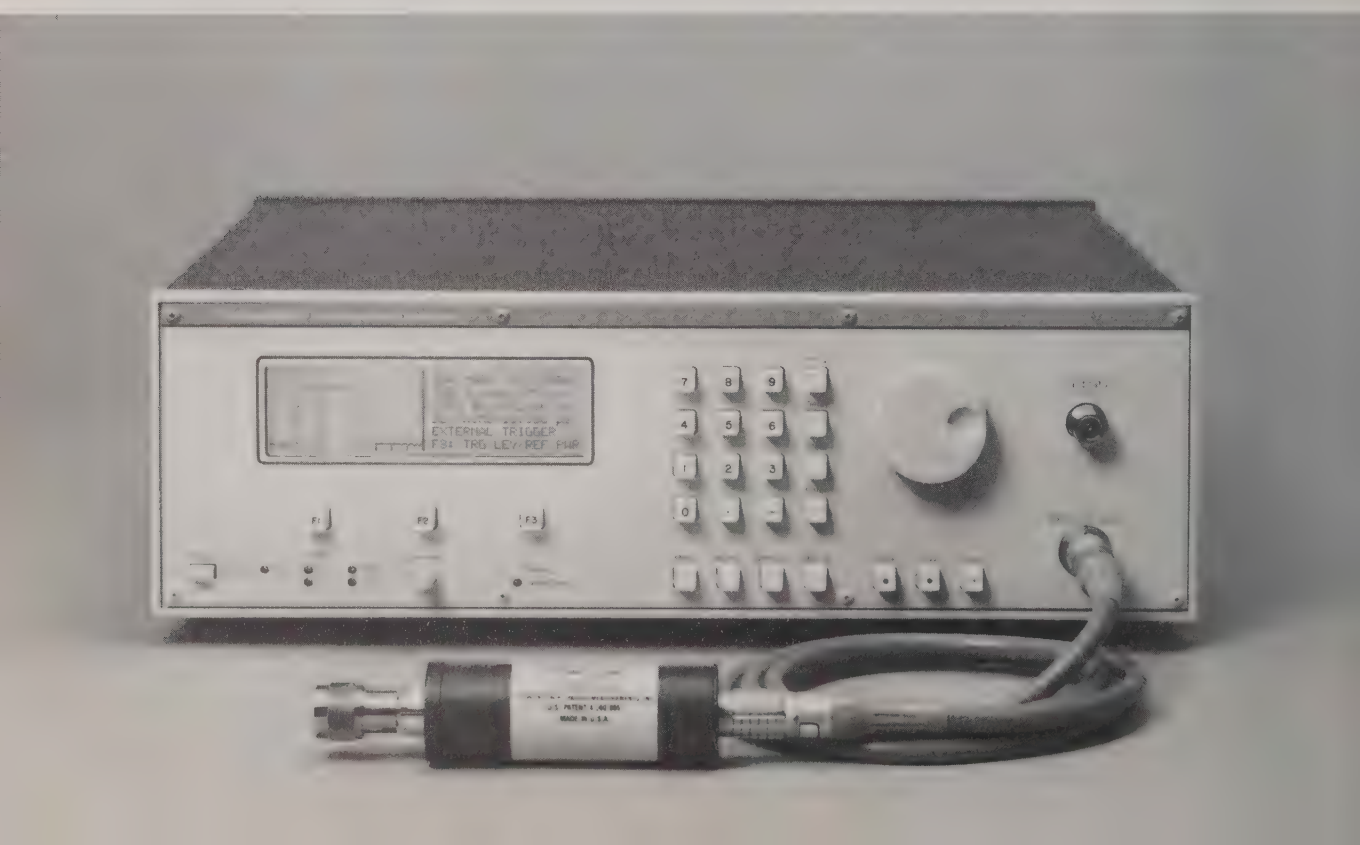
- **Single or Repetitive Pulse and CW Measurements from 30 MHz to 40 GHz**
- **Accurately Reads Pulses to 15 Nanoseconds**
- **Graphics Mode for Plot of Pulse and Reading Point**
- **Automatic Detector Calibration**

Series 8500 RF Peak Power Meter brings you an unexcelled combination of speed, accuracy, reliability and operator convenience. The versatile Series 8500 sets a new standard for the industry with its ability to accurately read pulses as narrow as 15ns, its exceptionally accurate CW performance and menu driven control, and a newly designed, completely automatic detector calibration system (patent pending).

Series 8500 provides detailed information on both single and repetitive pulses as narrow as 15 ns, regardless of the shape of the pulse and anywhere within the 30 MHz to 40 GHz frequency range.

By adjusting the delay, either automatically or manually, peak amplitude can be sampled and measured. If the delay is stepped through a series of small increments, data can be recorded over the entire pulse interval. A plot of this data provides a clear representation of the RF power over the entire pulse. The delay has sufficient range to also permit sampling of individual pulses in a train of pulses.

Series 8500 combines pulse measurement capability with the ability to make accurate CW readings over a 60 dB dynamic range (−40 to +20 dBm), with calibration readily traceable to National Calibration Standards Laboratories. Due to the large signal capacity and superior detection sensitivity, a single balanced detector reads both pulse and CW power over the full dynmaic range of the instrument. It is no longer necessary to use two different instruments to accurately measure pulse and CW power.



SERIES 8500 MICROWAVE POWER METERS

Through interactive prompts and soft key operated menus, the user can quickly and easily make a measurement. Most manual measurements can be made automatically, and functions controlled through the front panel can also be controlled remotely through the GPIB. The LCD display provides the operator with peak power, trigger delay, pulse width, and rise and fall times. A special graphics mode plots the outline of the detected pulse onto the display along with a cursor at the point at which the reading is being taken, thus allowing the operator to monitor system performance and guarantee the accuracy of power readings and delay adjustments.

A major advancement in instrument accuracy and NBS traceability has been accomplished with the automatic calibration of the detector linearizing circuitry in the unit. This system consists of a computer-controlled calibrator circuit which permits the diodes of the detector to be linearized against an internal thermal reference.

Two types of detectors with a variety of connectors are available for the Series 8500. One detector type has a minimum pulse width capability of 15ns, and the other type will measure to 750ns at frequencies to 30MHz when the measurement of narrower pulses is not required (such as in TACAN, various RADAR, and TDMA applications).

A ROM containing factory-measured frequency response data is built into each detector. This data automatically corrects the power reading at any measurement frequency. The measurement frequency can be entered manually or automatically via the GPIB bus, or by applying an external analog voltage corresponding to the frequency ($V \propto F$).

The detector connects to the instrument using a rugged, double shielded cable terminated in high-quality, locking connectors. Double shielding provides good EMI protection, and the rugged design of the cable assures reliable operation.

The crystal-controlled digital delay generator used in Series 8500 gives very high accuracy and reliability over a wide delay range. A delay line allows the leading edge of the pulse to be sampled, and very short RF pulses, when pre-triggering is not available, can be accurately measured. Pulse peak and shape information is provided automatically.

A programmable offset can be used to compensate for losses inherent in directional couplers and attenuators and parasitic losses in the RF components used to sample the RF power. This allows the display of true power being delivered to the point of interest.

Hardcopy pulse profiles are easily made by using a point plotter connected to the GPIB interface of the instrument. No other controller is required. The plot is fully annotated including time, date, and part identification.

Series 8500 is compatible with its predecessor, the Model 1018B. The Series 8500 not only fits in the same rack as the 1018B, but can respond to the same bus commands, thus assuring software compatibility with any existing systems now using the 1018B.

Series 8500 can be used in conjunction with Wavetek Models 1038-NS20 and N10 Network Analyzers to make swept peak power measurements.

Series 8500 is available in two different versions: Model 8501 has a single detector input, and the Model 8502 dual detector input, two channels for increased measurement capability.

Series 8500 can automatically enter specific frequency information as long as the RF source being used is equipped with a voltage proportional to frequency output.

Frequency Range
30 MHz to 40 GHz.
Power Range
Pulse Mode: −20 to +20 dBm.
CW Mode: −40 to +20 dBm.
Accuracy
Calibrator Power Uncertainty (at 1 mW): ±1% (0.044 dB).
Linearity: ±2% (0.066 dB).
Calibration Factor Uncertainty:
30 MHz to 10 GHz: ±1½% (0.065 dB).
10 GHz to 18 GHz: ±2½% (0.110 dB).
18 GHz to 26.5 GHz: ±4% (0.170 dB).
Reading Rate
>1000/s (counts down above this).
Maximum PRF
>1 MHz.
Sample Delay
Resolution: 0.1ns or 5 digits.
Range: 0 to 200 ms.
Accuracy: 0.01% of delay ±1ns.
Calibrator
Frequency: 1 GHz ±5%.
Power Uncertainty at 1 mW: ±1%.
Automatic Calibration Cycle: −33 to +20 dBm.
Return Loss @ 1 mW: >25 dB.
Self Calibration Time: <1 minute.
Connector: Type N.
Power Requirements
100, 120, 220, or 240 Vac rms ±10% 50, 60, or 400 Hz ±5%.
Environment
Operating: 0° to 50°C (+32° to +122°F).
Storage: −40° to +65°C.

OPTIONS

01: Rack Mount
02: APC7 Connector on Calibrator
03: Rear Panel Connection — Detector and Calibrator
04: Internal MATE Interface

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 8501 (Single Channel) (W/15ns, 18 GHz Detector)	**$9870**
Model 8502 (Dual Channel) (Two 15ns, 18 GHz Detectors)	**$13,940**
Option 01	**$150**
Option 02	**$225**
Option 03	**$75**
Option 04	**Consult Factory**

Microwave Peak Power Meter

- **100 MHz to 26.5 GHz**
- **10 μW to 10 mW Peak**
- **Reads in mW or dBm**
- **Measures a Single Pulse**
- **Three Trigger Modes**

Model 1018B, a direct reading peak power meter, measures power on a single pulse, repeating pulses, or CW. Three trigger modes (Internal, External, and Free Run) plus an adjustable measurement gate, which can be placed at the desired point by use of trigger delay circuitry, add to its versatility.

The 1018B measures and digitizes its readings in only 1 ms and readings can be made at rates up to 500/s. Single pulses down to 200 ns can be sampled and displayed in either dBm, mW, or on the 1018B's three digit readout. Three fixed "Coupler-dB" ranges can be used with external couplers or attenuators to extend the measurement range for high power applications.

A GPIB option (05) can be specified, which will provide an isolated data output, as well as bus control for the trigger and trigger delay.

SPECIFICATIONS

Frequency Range
100 MHz to 18 GHz (to 26.5 GHz with Option 07).
Power Range
10 μW to 10 mW (-20 to +10 dBm).
Accuracy
Linear (μW, mW): 5% of reading.
Logarithmic (dBm): ±0.3 dB.
Calibrator Output
High Level: +10 dBm ±0.06 dB.
Low Level: −20 dBm ±0.10 dB.
Impedance: 50Ω.
Return Loss: 31 dB.
Frequency: 105 MHz nominal.
Trigger Reset
Automatic: 0.3 Hz to 500 Hz.
External: +1.5V, ±10V max; width >0.5 μs; timing >1 μs prior to pulse which is to be measured; >1 kΩ input impedance.
Manual: Front panel pushbutton.
Environment
Operating: +15° to +45°C.
Storage: −40° to +65°C.
Power
100, 120, 220, 240 VAC, ±10%, 50 to 400 Hz, 40 VA maximum.

OPTIONS

02: APC-7 Connector
04: Isolated Data Output
05: GPIB (includes Option 06)
06: Trigger Delay Divider
07: 26.5 GHz Measurement Range
Model 1031: Rack Adapter for Model 1018B

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 1018B	**$7295**
Model 1018B/02	**$7625**
Model 1018B/07	**$7825**
Model 1031	**$80**
Option 04	**$795**
Option 05	**$1275**
Option 06	**$195**

Microwave CW Power Meters

Model 1045/01 RF Power Meter
Model 1045/01 RF Power Meter is a high speed, wide dynamic range, multiple detector, CW power meter for bench and ATE applications. It uses standard single diode detectors with Type N, APC7, and APC3.5 connectors. Readings are taken on a large LED display in db, dBm, W, mW, μW (includes over-range indication).

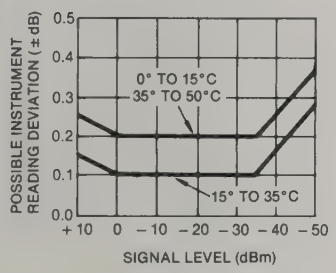
SPECIFICATIONS

Frequency Range
1 MHz to 26.5 GHz.

Power Range
– 50 dBm to + 10 dBm.
– 20 dBm to + 40 dBm.
(Range depends on detector used.)

Speed
Up to 500 readings/s.
Data to bus: 200k bytes/s.

Instrument Accuracy



Model 1045 Detector Measurement Accuracy from 1 MHz to 28.5 GHz

Response Time
1 ms to 10 s depending upon level change between readings.

Detector Calibration
30 MHz @ 10 mW ± 1.5%.
50Ω impedance.

Analog Output
dBm ranges: 100 mV/dB ± 1%.
Watt ranges: 1.0V per 1000 counts ± 1%.

Environment
Operating: 0° to + 50°C.
Storage: – 40° to + 65°C.

Power
100, 120, 220, and 240 VAC ± 10%; 50 to 440 Hz; 24 VA nominal.

OPTIONS

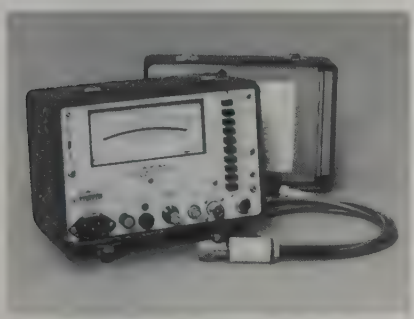
02: APC7 Connector on Calibrator Output
04: BCD data output
05: GPIB Capability (IEEE 488)

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 1045/01	**$5100**
Option 02	**$225**
Option 04	**$850**
Option 05	**$1250**
Detectors	**Contact Sales Rep**
Accessories	**Contact Sales Rep**



Model 1034A Portable Power Meter
Model 1034A is a lightweight, portable CW power meter for both bench and field use. A durable, moisture-proof case and the ability to operate with either battery or AC power makes the unit excellent for field use. It has many outstanding and unique features, not usually found in a small power meter. No warm-up is required unless the unit has been subjected to a sudden, drastic change of ambient temperature. Even then, a half hour warm-up is adequate. Power readings are shown on a large analog meter with 7 ranges in dBm and watts, including one range covering -40 to + 10 dBm. All readings are taken with a single diode detector having a Type N connector. Adapters available for other types.

System Configuration
Model 1034A comes complete with an internal battery pack and RF detector.

SPECIFICATIONS

Frequency Range
1 MHz to 18 GHz

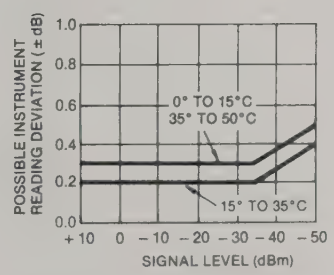
Power Range
60 dB (-50 to + 10 dBm)

Detector Calibrator
30 MHz @ 10 mW ± 1.5%.

Analog Output
1.1V full scale.

Environment
Operating: 0° to + 50°C.

Instrument Accuracy



Model 1034A Detector Measurement Accuracy from 1 MHz to 10 GHz. (Add 0.2 dB to the above for frequencies from 10 GHz to 18 GHz.)

Power
115/230 VAC ± 10%; 50 to 440 HZ; 10 VA nominal.

FACTORY/FOB

Sunnyvale, CA

PRICE

Model 1034A (Including Detector)	**$2475**

Instrumentation Controllers

- **16-bit CPU 68000 For High Speed Data Processing**
- **Multi-tasking And Real-Time Processing**
- **Enhanced BASIC With Structured Programming**
- **High Resolution CRT With Full Dot Graphics**
- **Additional Slots For System Expansion (Memory And I/O Cards)**

Introduction
Over the past few decades, instrumentation has developed from totally manually operated instruments to more sophisticated instruments capable of remote control. This control took a giant step forward in 1975 when IEEE adopted their 488 standard which defined a standard mechanical and electrical interface by which instruments could be controlled. Wavetek, along with other instrumentation companies, participated in the development and the adoption of this standard and, in fact, Wavetek was one of the first companies to bring out a product, the Model 159 in 1975, that adopted this standard. Since then, Wavetek has developed a whole generation of products, based on this IEEE 488 standard. In 1983 we made the next step, the introduction of our first instrumentation controller, the Wavetek Model 6000.

Designed to Think Like a Test Engineer
Engineers have been forced to choose between computers that were flexible and powerful but not designed for instrumentation control, or special purpose controllers with limited memory and speed. Model 6000 has the best of both.

It can contain up to 6.5 megabytes of user memory and operate in a multi-tasking, parallel processing environment. A special version of enhanced BASIC has been created that simplifies programming and merges separate programs written by different people.

Special attention has been given to the need for high speed data acquisition. The Model 6000 provides Direct Memory Access (DMA) as a standard capability, giving it a maximum data transfer rate of 200 Kbytes per second on GPIB interface. Additional optional I/O channels are serial (RS232 or TTY), GPIB, parallel, or a multi-channel analog to digital converter.

Multi-tasking
Modern computer processing speed far exceeds the measurement speed of the average instrument. A computer dedicated to instrument control addresses instruments and then waits a period of time, receives a little data and then waits another period of time, and so on. The declining cost of computers and rising cost of labor still makes this cost effective.

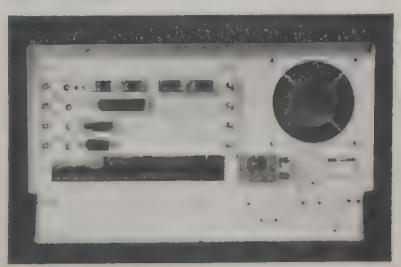
In many cases it is desirable to run an analysis program on the data taken, run a peripheral process such as an oven that is cycling the unit under test, and consolidate data taken previously. If each of these tasks is performed in a serial manner the tester is not as efficient as possible and the overall testing takes longer. It becomes increasingly desirable to be able to run tasks in parallel. Larger, more sophisticated minicomputers have been able to run tasks in parallel, but until now desktop computers have not had this capability.

With the Wavetek 6000, multitasking in a desktop has become a reality. Up to eight separate programs can be run at one time allowing you to address and control instrumentation, receive real time data, and still process data already stored. This new capability allows you to multiply the usefulness of your instrumentation controller without multiplying its cost.

Microprocessor
The heart of the Model 6000 is a Motorola 68000, a state of the art 16/32-bit microprocessor, that allows us to put minicomputer speed and flexibility into a desktop unit. Its multiple registers and stacks, large addressing range, memory management, and powerful multilevel vectored interrupts make possible the multi-tasking of up to 8 separate programs for high utilization of CPU and shorter overall test time. It also allows the use of an enhanced version of BASIC developed specifically for instrumentation control. This version accommodates multi-tasking and has expanded program flow statements that facilitate structured programming and powerful I/O.

Versatile Rear Panel
Both the 384K RAM Model 6000 and the 512K RAM Model 6000A have five I/O slots and two memory expansion slots. I/O slots will accommodate memory expansion cards but memory expansion slots will not accommodate I/O cards. The machines are configured at the factory as follows:

	6000	6000A
I/O slots with GPIB card factory installed	1	1
I/O slots available to user	4	4
Memory expansion slots with 128K card factory installed	1	0
Memory expansion slots available to user	1	2
Total slots for additional user I/O	4	4
Total slots for additional user memory	5	6



ANSI Extended BASIC

The ANSI extended BASIC conforms with the American National Standards Institute (ANSI) proposed as an international BASIC standard. Top-of-the-line software technology has developed a real-time BASIC language with further enhanced input/output control and GPIB control statements, allowing easy programming, powerful functions, and advanced programming. The ANSI extended BASIC offers various functions including:

- Structured programming statements
- Parallel processing
- Exception handling
- Subprogram statements
- File processing
- Extended function definitions
- Graphics statements
- I/O control statements
- GPIB control statements
- Matrix operations

Parallel Processing Function

The parallel processing function implements execution of more than one program according to predetermined priorities. For example, when the quick response to an external event is needed during printout or data processing, a higher priority can be assigned in advance to interrupt the operation. The parallel processing function allows programming work to be divided, thus saving time in program development and maintenance.

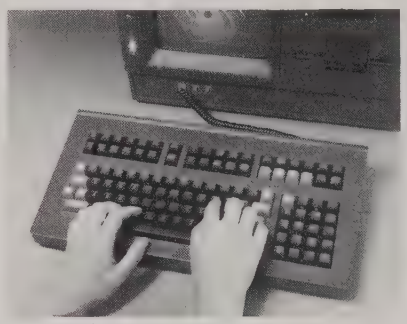
Three Stage Error Checking

When a program is entered, it is checked from three standpoints: syntax check during line editing, structure check at the completion of editing, and run-time check. If any error is found, the corresponding error message is displayed on the system message area.

Keyboards

Model 6000 comes standard with a full ASCII detachable keyboard equipped with 12 special function keys, multiple editing keys, and a full numeric keypad.

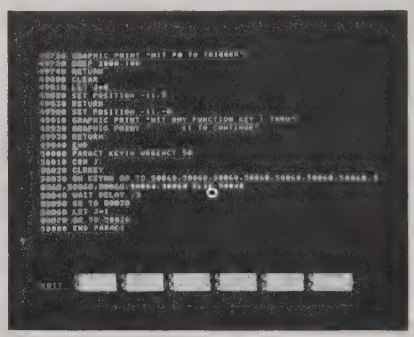
As an option we supply a simplified operator keyboard that mounts directly below the CRT on the front panel, supplying numeric keys and the 12 special function keys. The detachable keyboard can be plugged in while the operator keyboard is in place to give full programming control and then removed to provide simplified operation and avoid operator confusion.



Keyboard

CRT Display

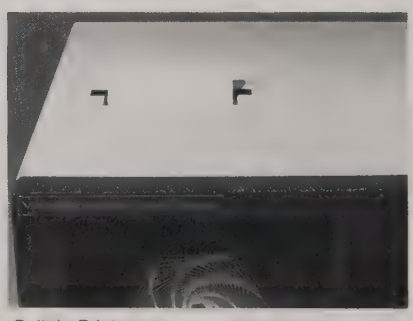
The CRT display screen is divided into sections for general information (user messages, key inputs, system messages, and functional key labels) allowing conversational interaction between the operator and the controller. The editor automatically provides line numbers and allows complete screen editing. The scroll buffer offers three screens, enabling high-speed scrolling.



CRT Display Screen

Optional Built-in Printer

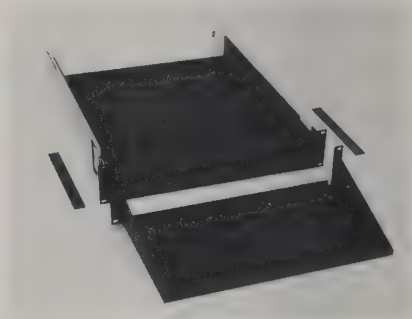
This thermal printer has the capability to print 35 characters per line at a rate of 1.5 lines per second. It can make hardcopies of programs, data, graphs, and characters from the CRT display. Because of its compactness, the printer is ideal for data output.



Built-in Printer

Rack Mount Kit

Model 6000 was designed as an instrumentation controller and will often be used in conjunction with racked equipment using a standard 19 in. rack. We have provided an adapter kit which allows the Model 6000 to be mounted on a tray with rack slides that bolt securely into the rack.



Rack Mount Parts

Documentation

Computer documentation is a difficult task at best and one that is most often done poorly. A computer is a very complex instrument particularly in the instrumentation and desktop computer world. Here the user is not a computer scientist, but a test engineer using the controller as a tool.

Model 6000 Manuals

Wavetek has spent a great deal of time to provide an outstanding documentation package.

We start with the *Introduction Manual* which describes the instrument physically and how to get started with programming. We provide 72 sample

programs that show by example how various tasks are performed on the Model 6000.

Second is the *BASIC Language Reference Manual* which contains a detailed description (plus a 'railroad' diagram) of each function, statement and command in the Model 6000 BASIC. Examples are shown, and remarks provide information about statement interactions, restrictions, or limitations relating to each function, statement, and command.

Third is the *Interfacing Manuals* for each of the I/O cards which include electrical/mechanical characteristics of the card as well as the language statements and how they operate specifically with that card.

A *Quick Reference Manual* is also available. It is an easy to use guide, in pocket form, that allows the programmer to quickly refer to the Model 6000 statements.

Model 6000 manuals offered are:
- Master Manual Package
- Introduction Manual
- BASIC Language Reference Manual
- BASIC Quick Reference Guide
- GPIB Operation Manual
- Parallel Operation Manual
- Serial Operation Manual
- A-to-D Operation Manual

Software
Besides the Extended BASIC, that is standard with the Model 6000, Wavetek offers Assembly Language and UCSD Pascal. Pascal has been enhanced to provide many of the IO enhancements available in BASIC. Because Pascal is a compiled language, it will run faster than BASIC. Assembly, of course, will be the fastest of all.

Model 6020 Assembly Language System
- Includes Text Editor, Macro-assembler, and Linkage Editor
- Full Scale 68000 Software Development Utility
- Can Be Incorporated Into Main BASIC Program

Model 6020 optional Assembler Language System consists of a text editor, macroassembler, and linking editor. It is a full-scale 68000 software development utility capable of being incorporated within the main BASIC program. When the BASIC language speed is not sufficient for certain applications, those sections can be written in assembly language and called from the BASIC program.

Assembler Functions are:

CALLB	LOADB
POKE	PEEK
POKEL	PEEKL
POKEW	PEEKW
VARADD	

Model 6021 Pascal Language System
- Includes File Manager, Editor, Compiler, Macroassembler, Linker, Debugger and I/O Library
- Supports Complete UCSD p-System
- Supports All Model 6000 I/O Cards Directly From Pascal

Model 6021 Pascal Language System is a complete UCSD p-System software development system. The option offers an integrated operating system and includes enhancement for all I/O cards offered on the Model 6000 Instrument Controller.

Translators
Many existing programs are written on older BASIC language computers. Some of the most popular are the HP85, HP9835, and HP9845 BASIC. We have written a translator for the HP85 to Model 6000 and for the HP9835/HP9845 to Model 6000. We have also written a translator for the HP9826/9836 to Model 6000. For those applications where a modern controller is being used and you want to take advantage of our multi-tasking capability, the programs must be written on the Model 6000.

Translators are:
- Model 6030, HP85 BASIC to 6000 BASIC
- Model 6035, HP9835/45 BASIC to 6000 BASIC
- Model 6036, HP9826/36 BASIC to 6000 BASIC

Applications Software
Model 6040 thru 6043 Applications Software are textbook solutions to common problems. They are programs written for the Model 6000 enabling it to solve common problems requiring these routes.

Model 6040 Math Library:
- Complex Numbers
- Determinant Calculation
- Inverse Matrix
- Simultaneous Primary Equations
- Various Random Number Generations
- Quadratic and Cubic Equations
- Nth Order Algebraic Equations

Model 6041 Statistics I Library:
- Basic Statistics
- Histograms
- Correlation Coefficients and Regressions

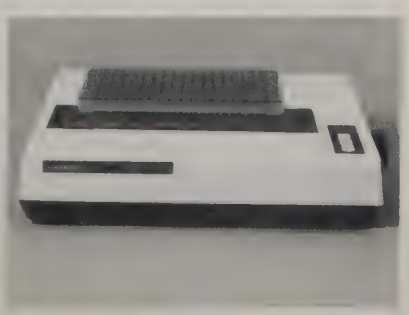
Model 6042 Statistics II Library:
- Analysis of Variance
- Analysis of Covariance

Model 6043 Fast Fourier Transform:
- Both BASIC and Assembly Language
- Fourier Analysis (FFT, IFT, Hamming, and Hanning)

Peripherals

Model 6010 80-Column Printer with GPIB Interface:
- 160 CPS Impact Dot Matrix
- Bit Image Modes, CRT Graphics
- Fanfold, Cut Sheet Or Roll Paper
- Multiple Character Sizes
- Single Keystroke Copies CRT Display

Model 6010 is an OEM version of the popular Epson FX80 with GPIB interface added for compatibility to the Wavetek 6000 Instrumentation Controller. Model 6010 prints a fast 160 cps or, in 'quiet' mode, 80 cps.



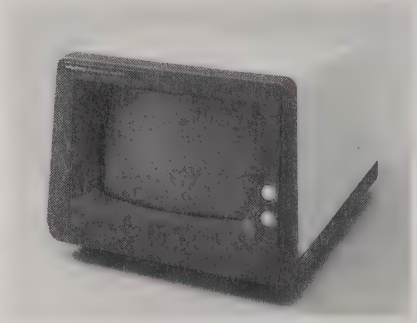
Model 6010 Printer

Model 6008 Floppy Disk Drive
- Dual 8-Inch Drives
- 1 Mbyte Per Diskette
- IBM 3740 Compatible
- Same Model 6000 BASIC Commands

Model 6008 Floppy Disk Drive

Model 6014 External Monitor
- Large 14-Inch Screen
- Functions As Remote CRT
- Switch For Model 6000, Monitor, Or Both

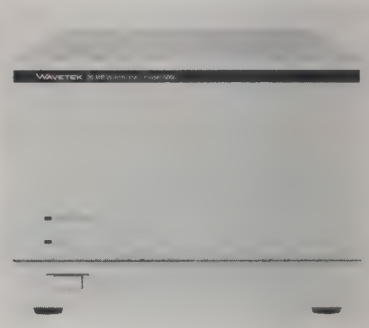
Model 6014 has many applications among which are teaching a large group from one Model 6000 or remote monitoring of the production area. A switch is included to permit use of just the monitor, the monitor and the built-in display of the Model 6000, or just the Model 6000 display.



Model 6014 External Monitor

Model 6006, 5¼ Inch Winchester Disk Drive
- 20 Mbyte Capacity
- For use with Model 6000 Instrumentation Controller.

For high speed and large data storage capacity, Wavetek Model 6006 hard disk offers the optimum solution. The high speed is achieved through the GPIB interface. Each hard disk has built-in intelligence to allow multiple users and shared access.



Winchester Disk Drive

SOFTWARE SPECIFICATIONS

ANSI Extended BASIC

Standard BASIC Statements

LET	GOSUB
RETURN	IF THEN
GOTO	DEF FN
STOP	FOR NEXT
PRINT	

Structured Programming Statements

DO LOOP	IF THEN ELSE
END IF	SELECT CASE
END SELECT	

Subprogram Statements

CALL	SUB EXIT
SUB	END SUB

Extended Function Defining Statements

DEF	END DEF
FUNCTION	

Multi-tasking Statements

CONNECT	DISCONNECT
EVENT	EVENT
PARACT	END PARACT
PARSTOP	START
PROCESS	SIGNAL
EVENT	WAIT EVENT
WAIT PACER	WAIT TIME
WAIT DELAY	

File I/O Statements

ASK	CLOSE
DELETE	FORMAT
OPEN	READ #
RESET	SCRATCH
WRITE #	

Other Statements

I/O-related
Debugging
Matrix operation

Mathematical Functions

Includes all normal math functions such as hyperbolic function SINH, TANH, etc., and the followng:

ABS	ATN
COS	EXP
INT	etc.

16-bit Binary Operation Functions

ADB	BIC
BIS	COM
EXB	LRO
LSH	RRO
RSH	SWP

Character String Functions

ASC	BSTR$
BTOH$	BTOO$
BVAL	CHR$
DATE$	HSTR$
HTOB$	HVAL
LEN	LWRC$
NOT$	ORD
OSTR$	OTOB$
OVAL	POS
STR$	TIME$
UPRC$	VAL

GPIB Control Statements

COMMAND
DCL (Device Clear)
EOI (End or Identify)
IFC (Interface Clear)
IST (Individual Status)
LCL (Local)
LLO (Local Lockout)
PARITY
PCT (Pass Control)
PPD (Parallel Poll Disable)
PPE (Parallel Poll Enable)
PPL (Parallel Poll)
REN (Remote Enable)
SRQ (Service Request)
STATUS (Serial Poll)
TRG (Group Execute Trigger)

Exception Handling Statements

EXLINE	EXTYPE
ENABLE	DISABLE
HANDLER	HANDLER
HANDLER	END HANDLER
RESURE	CONTINUE
RETRY	CAUSE

Graphic Functions

SET BOUNDS	ASK BOUNDS
SET LINE	CLEAR
STYLE	
SET	ASK VIEWPORT
VIEWPORT	ASK WINDOWS
SET	
WINDOWS	

HARDWARE SPECIFICATIONS

CRT Monitor

Size: 240 mm (9.5 in.) diagonal.

Floppy Disk Drives

Double sided, double density, 300 Kbytes per drive.
First drive standard, second drive optional.

GPIB

Type: Direct Memory Access (DMA).
Transfer rate: 200 Kbytes/Kbytes.

Parallel I/O

I/O Lines: 16 lines with DMA.
T/R Rates: Up to 200K words.

MODELS 6000/6000A INSTRUMENTATION CONTROLLERS

Processor
Type: Motorola MC68000.
Clock Frequency: 8 MHz.
Internal Architecture: 32-bit data/address registers.
Address Range: 16 Mbytes.
Data Bus: 16 bit asynchronous.

Memory
ROM: 16 Kbytes (operating system and BASIC).
RAM: 384 Kbytes with parity, >160 Kbytes available to user.
Expansion: To 6.5 Mbytes in 128 Kbyte, 256 Kbyte, or 1 Mbyte increments.

Graphics Display
Controller Chip: NEC 7220.
Resolution: 512 dots horizontal, 348 dots vertical.
Density: 32 dots/cm (81 dots/in.).
Graphic Buffer: 4 graphics planes (32 Kbytes each) 128 Kbytes total (separate from main memory).

Parallel I/O
Bidirectional I/O lines: 16.
Status input lines: 8.
Status output lines: 8.
Additional lines: 1-REQ (input).

Serial I/O
Formats: RS232C or 20 mA current loop.
Baud rate: From 50 to 9600 baud.

A/D Conversion
Card Input: 8 single ended or 4 differential analog channels.
Input Levels: Shielded ±10V.
Type: High speed successive approximation converter.
Resolution: 12 bits with single channel conversion rate of 30 μs. (200 μs when 4/8-channel scanner is used.)

GENERAL

Environment
Operating Temperature: 10 to 40°C, relative humidity 5 to 95% noncondensing.
Storage: 5 to 45°C.

EMI
FCC class A.

Dimensions
280 mm (11 in.) high; 436 mm (17 in.) wide; 650 mm (26 in.) deep.

Weight
33 kg (72 lb) shipping.

Power
100 to 127V or 200 to 254V; 50 to 60 Hz; less than 200 VA.

OPTIONS

001: 128K Memory Board
001A: 256K Memory Board
002: Operator Keyboard
003: Built-in Thermal Printer
004: Second Built-in Disk Drive
005: External Interrupt Interface
006: Additional GPIB Interface Card
007: Parallel I/O Interface Card
008: Serial I/O Interface Card
009: A/D Conversion Card
010: Software Update Service (1 year)
011: Matrix/Advanced Graphics

ACCESSORIES

GPIB Cable (1 meter)
GPIB Cable (2 meters)
Parallel Interface Cable, One-end
Serial Interface Cable, Modem-end
Serial Interface Cable, Terminal-end
A to D Cable, 1 per Channel
5.25-inch Floppy Disks, Box of 10
Transit Case for Model 6000
Rack Adapter Kit

FACTORY/FOB

San Diego, CA

PRICE

Model 6000 **$7950**
Includes 384 Kbytes Memory (160 User) 1 Floppy Disk, Extended BASIC, 1 GPIB card, 5 Slots for Expansion.

OPTIONS

Option 001 **$450**
128 Kbytes
Option 001A **$700**
256 Kbytes
Option 002 **$300**
Operator Keyboard
Option 003 **$800**
Built-in Printer
Option 004 **$650**
2nd Floppy Drive
Option 005 **$400**
External Interrupt
Option 006 **$550**
2nd GPIB
Option 007 **$550**
Parallel I/O
Option 008 **$450**
Serial I/O
Option 009 **$850**
A to D I/O
Option 010 **$300**
One Year Software Update
Option 011 **Included**
Matrix/Advanced Graphics

PERIPHERALS

Model 6006 **$4850**
20 Mbyte Hard Disk Drive
Model 6008 **$2950**
8-In. Dual Floppy Drive
Model 6010 **$700**
Printer
Model 6014 **$1350**
External Monitor

SOFTWARE

Model 6020 **$1350**
Assembly Language
Model 6021 **$1750**
UCSD Pascal

TRANSLATORS

Model 6030 **$250**
HP85 to Wvtk 6000
Model 6035 **$250**
HP9845 to Wvtk 6000
Model 6036 **$250**
HP9826 to Wvtk 6000

APPLICATIONS SOFTWARE

Model 6039 **$250**
Autograph
Model 6040 **$250**
Math Library
Model 6041 **$250**
Statistics I Library
Model 6042 **$250**
Statistics II Library
Model 6043 **$400**
FFT

NEW

Model 6000A **$8850**
Same as Model 6000 but with 512 Kbytes of Internal RAM
Option 001B **$1450**
1 Mbyte RAM Memory Expansion Card
Option 014 **$3250**
512 Kbyte Bubble Memory Card
Option 015 **$4500**
384 Kbyte Bubble Memory Cartridge System
Option 016 **$8950**
Dual 384 Kbyte Bubble Memory Cartridge System
Option 013 **$1050**
Four Channel Serial I/O Card
Option 012 **$1200**
Two Channel Digital to Analog Converter Card

Matrix/Advanced Graphics software is now included with 6000/6000A

SIGNAL SWITCHING SYSTEM SELECTION GUIDE

Model	Function	Max Frequency	No. of Switches	Contact Type/Rating	Catalog Page
Model 600 Signal Switching System (Accepts Modules)					
601 **Opt 001**	Main Chassis Memory Expansion	N/A N/A	N/A* N/A	N/A N/A	164
602 **Opt 002**	Expansion Chassis (with 1 ft cable) 601/602 Interconnect Cable, 5 ft	N/A N/A	N/A** N/A	N/A N/A	164
603 —	Control Panel Extender Cable	N/A N/A	N/A N/A	N/A N/A	166
Model 604 200-MHz Programmable Signal Switcher (Self-contained)					
604	Self-contained A-Band RF Small Systems Switching	200 MHz	10	200V, 0.5A, 10W	163
Plug-in Modules (610-620) for 601 and 602 Chassis					
610	A-Band RF Switching	200 MHz	10	200V, 0.5A, 10W	166
611	B-Band RF Switching	500 MHz	10	100V, 2A, 60W	167
612	Matrix/RF Switching	250 MHz	16 (4 × 4)	100V, 2A, 60W	167
613	General Purpose I/O (Output on 50-pin sub-min. "D" Connector; also 2 lines each have 50Ω BNC Output)	N/A	16 Channels	16 TTL Drivers (+20/−10 mA per line) and 16 Relay Drivers with 40V/200 mA drive capability	168
614	High Power Switching	N/A	5	250 VAC, 5A, Max 500 VA	168
615	Low Level Switching	⩽1 MHz	10	100V, 200 mA, Max 5W, <0.2Ω, <1 μV	169
616	J-Band Microwave Switching	18 GHz	2	70V, 1.4A (N.S.)	169
617	Attenuation (0 to 85 dB, 1 dB steps, 2 sections)	250 MHz	2 Sections	20V, 2A, 5W Continuous Power	170
618	D-Band RF Switching	1.5 GHz	10	100V, 2A, 60W	170
619	Breadboard/Customer Defined	Customer defined	16 Channels	1 LS TTL per each of 16 lines	171
620	K-Band Microwave Switching	26.5 GHz	2	Max 250 W @ 100 MHz; derates to 15 W @ 26.5 GHz	171

*Main Chassis acepts 3 plug-in switch modules.
**Expansion Chassis accepts 4 plug-in switch modules.

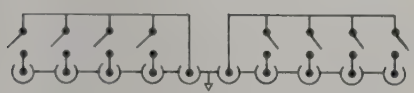
200 MHz Programmable Signal Switcher

Model 604, a dc to 200 MHz Programmable Signal Switcher, contains two four-channel switch groups in a star configuration. Switch selection, operation and modes are controlled by front panel or GPIB.

SPECIFICATIONS

SWITCHES

Number of Switches
8 in 2 groups.



Insertion Loss
≤0.5 dB @ 100 MHz.
≤1 dB @ 200 MHz.

Crosstalk
Any channel to any channel, all switches open:
≤ – 70 dB to 10 MHz
≤ – 50 dB to 100 MHz
≤ – 40 dB to 200 MHz.

Isolation
One signal path, input to output, one switch open:
≤ – 55 dB to 10 MHz
≤ – 35 dB to 100 MHz
≤ – 30 dB to 200 MHz

Risetime
≤2 ns.

Maximum V/A/W
200 V, 0.5 A, 10 W.

Switch Contact Resistance
≤0.25 Ω per switch.

VSWR (Typical)
≤1.03 @ 10 MHz,
≤1.15 @ 100 MHz,
≤1.51 @ 200 MHz.

Switching Time
≤1 ms.

I/O Connections
10 BNC female connectors.

PROGRAMMING

Local and GPIB Parameters
Multiple/Single: Multiple mode allows any combination of switches to be closed. Single mode allows only one switch of each group to be closed.
Make 1st/Break 1st: Make 1st is Make-Before-Break mode. Break 1st is Break-Before-Make mode.
Open/Close: Open or close designated switch.
Remote/Local: GPIB or front panel control selection. Remote LED lights when the 604 is under GPIB control.

GPIB Only Parameters
Execute: Transfers the program to the switches.
Reset: Returns the 604 to its power-on conditions.

GPIB
IEEE 488-1978 compatible, non-isolated, double buffered, listen only.
Address: 0 to 30; externally switch selectable.
Subsets: AH1, DC1, DT1, L3, RL1.
Timing: All parameters ≤25ms.

GENERAL

Environment
Temperature Range: 0 to 50°C.
Warm-up Time: 0 hours.
Altitude: Up to 10,000 ft for operation; up to 40,000 ft for storage.
Relative Humidity: 90% noncondensing.

Dimensions
21.6 cm (8½ in.) wide, 8.9 cm (3½ in.) high, 27.9 cm (11 in.) deep.

Weight
2.3 kg (5 lb) net; 3.6 kg (8 lb) shipping.

Mounting
Shelf, bench, or in a "half 19-inch" rack mount adapter.

Power
90 to 260 Vac, 48 to 66 Hz, 1 phase, ≤10 W.

FACTORY/FOB

San Diego, CA

PRICE

Model 604	**$795**

System Chassis and Expansion Chassis

- **Low Cost, High Performance**
- **Small Size, Bench or Rack**
- **Wide Variety of Switch Modules**
- **Maximum Configuration Flexibility**
- **GPIB and Stored Settings Standard**

Model 601
Model 601, the main chassis for the 600 Signal Switching System, houses the GPIB interface, stored setting memory, power supply and up to three switch modules. The Model 601 supplies all the power and controls for the optional Models 602 (Expansion Chassis) and 603 (Control Panel).

Model 602
Model 602, Expansion Chassis, provides room for four additional switch modules. The Model 602 receives all its power and commands from the Model 601.

Mounting
Both chassis measure only 8 inches deep and can be mounted at the rear of a rack, switch modules facing rearward. If the manual control panel (Model 603) is not required (GPIB operation only), no front-of-rack space is used up. Both chassis are convenient depth for bench or shelf usage.

Modules
A variety of switch modules provide flexibility and performance at a low cost. Applications from DC to 26 GHz as well as low level (<1μV), high voltage, and power switching are covered. For module specifications, see pages 134 through 139.

MODELS 601 & 602 PROGRAMMABLE SIGNAL SWITCHERS

MODEL 601 CHASSIS

Switch Module Slots
3. Numbered 1 thru 3.

Programming
Control of Model 601 and switch modules is via the GPIB or Model 603 control panel.
Program parameters are:
Module Number: Selects one of the up to seven modules in a Model 600 system.
Switch Number: Selects a switch within a module.
Open/Close: Opens or closes a switch.
Delay Mode: Specifies the actuation mode of each individual relay. Actuation modes are: open and close immediately; delay on open; delay on close; delay on both.
Delay Time: The actuation delay as it applies to the delay mode. The delay of each individual switch can be set from 0 to 175 ms in eight steps.
Group Break Before Make: Programs all switches in one module to operate as break-before-make.
Group Make Before Break: Programs all switches in one module to operate as make-before-break.
Group Immediate: Programs all switches in one module for immediate make and break operation.
Trigger Slope: Configures trigger circuit to respond to input of + slope or − slope, or not to respond to input.
Execute: Transfers all switch programs to the module circuits.
Reset: Returns Model 601 and all modules to the power-on condition.

Stored Settings
A stored setting holds the configuration of every switch in the system (including expansion chassis). Settings can be stored, recalled, or deleted via the GPIB or control panel, incremented via an external trigger or GPIB, and are non-volatile (backed by battery for 6 months minimum). Model 601 has 10 settings standard with an additional 40 (50 total) available optionally.

GPIB Programming
IEEE 488-1978 compatible, non-isolated, double buffered.
Address: 0 to 30; externally switch selectable.
Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.
Interface Timing: All parameters less than 25 ms.

External Trigger Input
Switch closure or TTL level change causes one increment of stored setting. >50 kΩ input impedance. Slope is programmable.

Trigger Output
TTL level change occurs at the completion of the longest switch delay. 500Ω source impedance.

MODEL 602 EXPANSION CHASSIS

Switch Module Slots
4. Numbered 4 through 7.

GENERAL

Environment
Temperature Range: 0 to 50°C.
Warm-up Time: 0 hours.
Altitude: Up to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 90% at 20°C and at sea level (non-condensing).

Dimensions
(Each Model)
Width: 43.2 cm (17 in.).
Height: 13.3 cm (5¼ in.).
Depth: 20.3 cm (8 in.).

Weight
Model 601: 5.2 kg (11½ lb) net; 6.8 kg (15 lb) shipping.
Model 602: 3.8 kg (8½ lb) net; 5.9 kg (13 lb) shipping.

Mounting
Models can mount at front or rear of a standard 19 inch rack or be placed on a shelf or bench. Optional control panel can be remote or attached to Model 601.

Power Required
90 to 108, 108 to 130, 198 to 238, or 216 to 259 Vac; 48 to 66 Hz; 1 phase; less than 40 W.

Power Distribution
The following power is available for modules:
Model 601: 10 W @ 12V, 1.5 W @ 5V.
Model 602: 12 W @ 12V, 1.5 W @ 5V.
The total number of switches turned on must not exceed this power. (See individual module specifications.)

OPTION

001: Additional Stored Settings 40 additional stored settings for Model 601 (total of 50).

ACCESSORIES

Extender Cable
Front panel to chassis, 5 ft extender cable for remote operation.

FACTORY/FOB

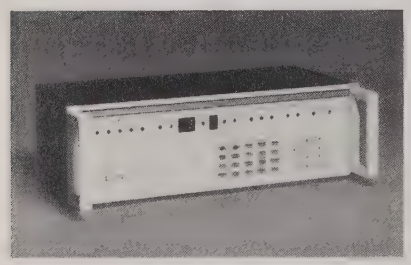
San Diego, CA

PRICE

Model 601	$995
Model 602	$450
Option 001	$125
Extender Cable	$45

Switching System Control Panel

- **Versatile Mounting**
- **Manual Switcher Control**



Model 603 provides manual control and status display of all switch parameters and stored settings, GPIB status information and error indications for the Model 600 Signal Switching System. Control panel can be mounted at the front of the rack with a cable to the Model 601 chassis mounted at the rear of the rack. The panel also can be nested into the 601 for rack or bench use.

SPECIFICATIONS

Programming and Stored Settings
See Model 601, Chassis.
Displays
Module: Number.
Switch: Number, delay, delay increment open/closed, delay open/closed.
Stored Settings: Store, recall, delete.
Trigger: On rising edge, on falling edge, off.
Execute: Error, execute required.
GPIB: Address, talk, listen, remote, SRQ.
Controls
Switch: Module, number, delay, mode, open, close.
Stored Settings: Store, recall, delete.
Group: Make first, break first, immediate.
Trigger: Input.
GPIB: Address, SRQ, local.
Tone: On/Off.
Power: On, standby.
Miscellaneous: 0-9 keypad, clear entry, reset, execute.
Environment
(See Chassis.)
Dimensions
Width: 43.8 cm (17¼ in.).
Height: 13.3 cm (5¼ in.).
Depth: 4.4 cm (1¾ in.) excluding handles.
Weight
1.6 kg (3½ lb) net; 3.2 kg (7 lb) shipping.
Power Required
From Model 601, Chassis.

ACCESSORIES

Extender Cable **$45**
Front panel-to-chassis, 5 ft extender cable for remote operation.

FACTORY/FOB

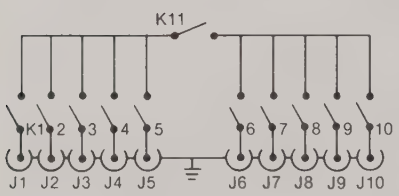
San Diego, CA

PRICE

Model 603 **$450**

200 MHz, 10 Channel Module

- **200 MHz Bandwidth**
- **Versatile Configuration**



Model 610, a 200 MHz RF module, gives maximum flexibility with two sets of five relays in a modified star. Any I/O connector can be connected to any other or to multiple I/O connectors; all can be disconnected as well. The two groups of five relays can be connected together via another relay.

SPECIFICATIONS

Insertion Loss: ≤0.5 dB @ 100 MHz.
Bandwidth: ≥200 MHz @ −3 dB.
Cross Talk: Any channel to any channel; all switches open:

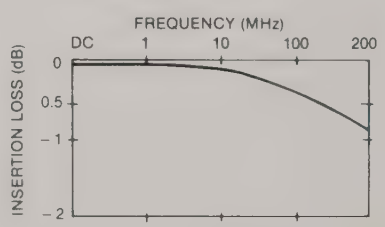
10 MHz	100 MHz	200 MHz
≤ −75 dB	≤ −55 dB	≤ −50 dB

Isolation: One signal path, input to output; one switch open:

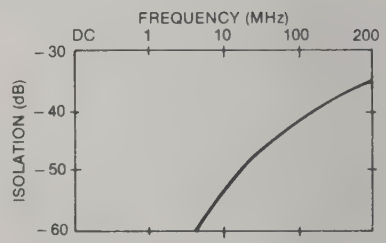
10 MHz	100 MHz	200 MHz
≤ −55 dB	≤ −40 dB	≤ −35 dB

Risetime: ≤2.0 ns.
Max V/A/W: 200V, 0.5A 10W.
Contact Resistance: ≤0.15Ω/switch.
VSWR (Typical): ≤1.1:1 @ 25 MHz, ≤1.2:1 @ 95 MHz.
Switching Time: ≤2 ms.
I/O Connections: 10 BNC, female.
Power Consumption:
1.0 W max @ 12V;
0.1 W per switch.

Typical Insertion Loss:



Typical Isolation:



FACTORY/FOB

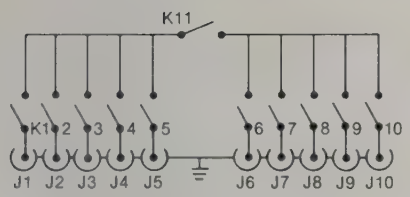
San Diego, CA

PRICE

Model 610 **$325**

500 MHz, 10 Channel Module

- 500 MHz Bandwidth
- Versatile Configuration



Model 611, a 500 MHz RF module, gives maximum connection flexibility by providing two sets of five relays in a modified star configuration.

SPECIFICATIONS

Insertion Loss: ⩽0.5 dB @ 100 MHz.
Bandwidth: ⩾500 MHz @ −3 dB.
Rise Time: ⩽1.0 ns.
Cross Talk: Any channel to any channel; all switches open:

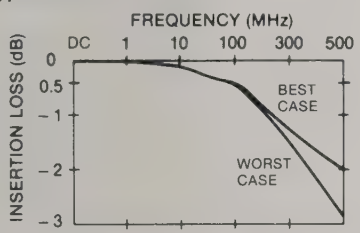
10 MHz	100 MHz	500 MHz
⩽ −100 dB	⩽ −90 dB	⩽ −60 dB

Isolation: One signal path, input to output; one switch open:

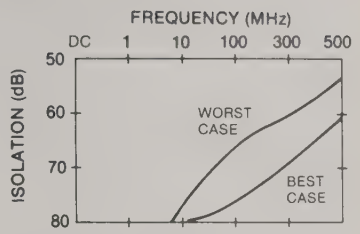
10 MHz	100 MHz	500 MHz
⩽ −70 dB	⩽ −60 dB	⩽ −50 dB

Max V/A/W: 100V, 2A 60W.
Contact Resistance: ⩽0.10Ω/switch.
VSWR (Typical): ⩽1.1:1 @ 25 MHz, ⩽1.2:1 @ 95 MHz.
Switching Time: ⩽10 ms.
I/O Connections: 10 BNC, female.
Power Consumption: 3.3 W max @ 12V; 0.3 W per switch.

Typical Insertion Loss:



Typical Isolation:



FACTORY/FOB

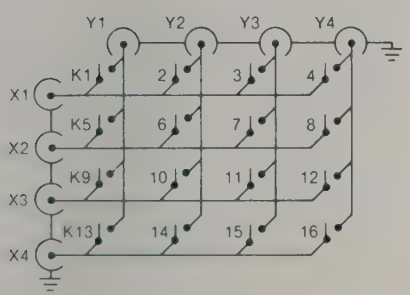
San Diego, CA

PRICE

Model 611 $750

250 MHz Matrix Module

- 4 × 4 Matrix
- 250 MHz Bandwidth



Model 612, a 250 MHz RF module, gives the ultimate in switching flexibility. The module is a 4 × 4 matrix allowing any port to be connected to any other port independently or all together and at the same time.

SPECIFICATIONS

Insertion Loss: ⩽0.75 dB @ 100 MHz.
Bandwidth: ⩾250 MHz @ −3 dB.
Rise Time: ⩽2.0 ns.
Cross Talk: Any channel to any channel; all switches open:

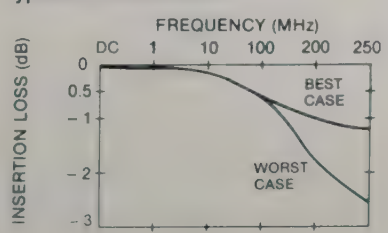
10 MHz	100 MHz	250 MHz
⩽ −75 dB	⩽ −70 dB	⩽ −60 dB

Isolation: One signal path, input to output; one switch open:

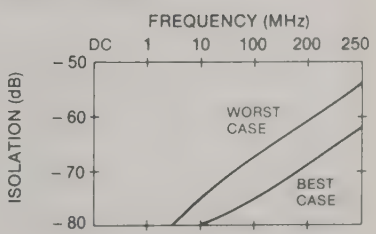
10 MHz	100 MHz	250 MHz
⩽ −70 dB	⩽ −60 dB	⩽ −50 dB

Max V/A/W: 100V, 2A, 60W.
Contact Resistance: ⩽0.15Ω/switch.
VSWR (Typical): ⩽1.1:1 @ 10 MHz, ⩽1.35:1 @ 50 MHz.
Switching Time: ⩽10 ms.
I/O Connections: 8 BNC, female.
Power Consumption: 4.5 W max @ 12V; 0.3 W per switch.

Typical Insertion Loss:



Typical Isolation:



FACTORY/FOB

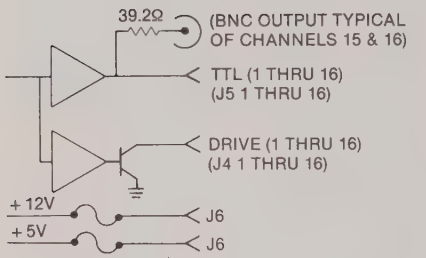
San Diego, CA

PRICE

Model 612 $950

General Purpose 16 Channel Driver Module

- **Drives External Devices**
- **Up to 16 Channels**



Model 613, a general purpose driver module, can drive devices external to the module, such as your own microwave switches, which may require a +12V level, or other devices that require a TTL signal or combination of TTL signals. It provides 16 channels of both TTL level drive and parallel 12V, 300mA open collector drive. To conveniently trigger external devices, two channels have additional BNC outputs. A fused +12V and +5V supply is available.

SPECIFICATIONS

I/O Connections: 50 pin subminiature "D" connector and 48 screw terminals.
TTL Output: +20/−10 mA maximum per channel.
Max Collector Voltage: +40 Vdc.
Max Collector Current: 200 mA.
+5V Supply: 100 mA maximum load.
+12V Supply: 300 mA maximum load.
Output Power Available:
3.6 W max @ 12V;
1.0 W max @ 5V.

FACTORY/FOB

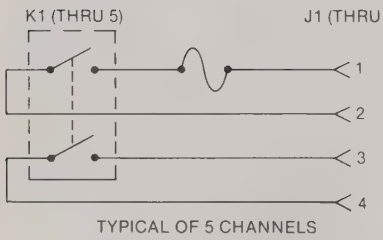
San Diego, CA

PRICE

Model 613 **$325**

High Power Module

- **Five Channels**
- **Fuse Protected**



TYPICAL OF 5 CHANNELS

Model 614 is a module that switches high voltages and currents. It can be used to switch line voltages and power supplies. One side of the double pole relays is fused. The fuse holders are conveniently located on the outside of the module. Also, insulating covers shield top and bottom of module to protect user from external high voltage.

SPECIFICATIONS

Contact Rating:
5A @ 30 Vdc,
3A @ 125 Vac,
2A @ 250 Vac.
Contact Resistance: ≤0.07Ω per contact.
Switching Time: ≤20 ms.
I/O Connections: 20 screw terminals.
Standard Fuse: 5A, fast blow.
Power Consumption:
1.8 W max @ 12V;
0.36 W per switch.

FACTORY/FOB

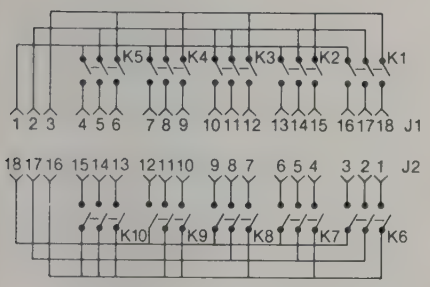
San Diego, CA

PRICE

Model 614 **$350**

Low Level 10 Channel Module

- Very Low Level Switching
- No Thermal EMF



SPECIFICATIONS

Signal Level: 100V, 200 mA, 5W.
Contact Resistance: <0.2Ω per contact.
Insulation Resistance: $>10^{12}\Omega$, <5pF.
Contact Potential: <1μV after 20 min warm-up (output to copper leads).
Switching Time: ≤2 ms.
I/O Connections: 36 screw terminals.
Power Consumption:
0.8 W max @ 12V;
0.08 W per switch.

FACTORY/FOB

San Diego, CA

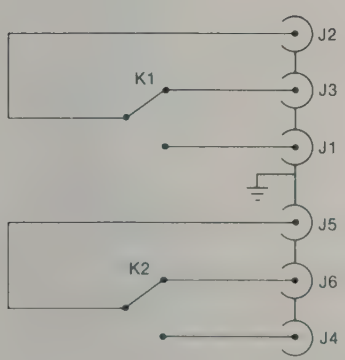
PRICE

Model 615 $525

Model 615, a low level, 10 channel module, switches very low level dc signals with relays that contribute no significant amount of thermal emf. There are two sets of five relays. Each relay is three-pole, single-throw for switching high, low and guard.

DC to 18 GHz Microwave Switch Module

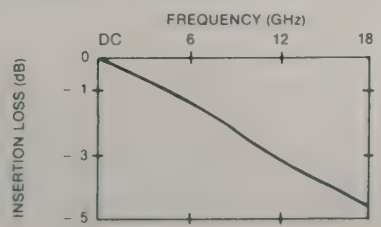
- 18 GHz Bandwidth
- Two Channels



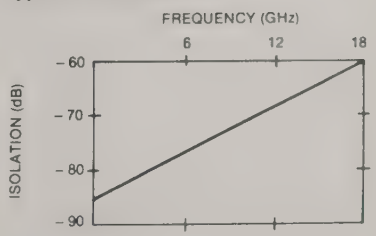
SPECIFICATIONS

Insertion Loss: ≤0.5 dB at 18 GHz.
Isolation: ≥60 dB at 18 GHz.
VSWR: ≤1.50:1 at 18 GHz.
Switching Time: ≤30 ms.
Switch Power: 100W at 100 MHz decreasing to 7.5W at 18 GHz.
Switch Rating: 70V, 1.4A no switching.
I/O Connections: 6 SMA female connectors.
Power Consumption:
4.5 W max @ 12V;
2.25 W per switch.

Typical Insertion Loss:



Typical Isolation:



FACTORY/FOB

San Diego, CA

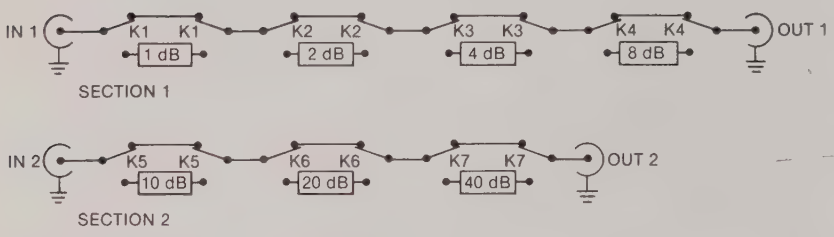
PRICE

Model 616 $895

Model 616, a dc to 18 GHz microwave switch module, provides the ultimate in RF switching quality. This module provides two channels of SPDT switching with 18 GHz bandwidth.

250 MHz Attenuator Module

- **Up to 85 dB Attenuation**
- **Two Separate Sections**



Model 617, a 250 MHz 5W attenuator, gives maximum flexibility by using two sections to provide up to 85 dB of attenuation in 1 dB steps. Section 1 contains four cells in 1, 2, 4, and 8 dB steps for a total attenuation of 15 dB. Section 2 contains three cells in 10, 20, and 40 dB steps for a total attenuation of 70 dB.

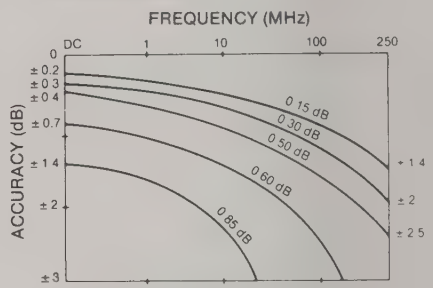
SPECIFICATIONS

Rise Time: ⩽1 ns.
Max V/A/W: 100V/2A/5W.
Contact Resistance: ⩽0.5Ω input-output.
VSWR: ⩽1.16 at 100 MHz;
⩽1.4 at 250 MHz.
Switching Time: ⩽10 ms.
Configuration: Two sections.

Accuracy (± dB):

	Attenuation Range (dB)				
Frequency (MHz)	0-15	16-30	31-50	51-60	61-85
DC-1	0.5	0.5	1	1	2
1-10	0.5	1	1.5	2	3
10-100	1	1.5	2	3	—
100-250	2	2.5	3	—	—

Attenuation:
Section 1: 1, 2, 4, and 8 dB.
Section 2: 10, 20, and 40 dB.
Impedance: 50Ω.
I/O Connections: 4 BNC, female.
Power Consumption:
2.3 W max at 12V; 0.3 W per switch.
Typical Accuracy:



FACTORY/FOB

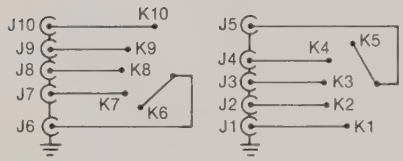
San Diego, CA

PRICE

Model 617 **$595**

1.5 GHz, Dual 1 of 4 Module

- **1.5 GHz Bandwidth**
- **Two Channels**



Model 618, a 1.5 GHz module, offers outstanding RF performance at a very attractive cost per channel. The module has two sets of 1 of 4 channels. Switch actuation mode is always break before make.

SPECIFICATIONS

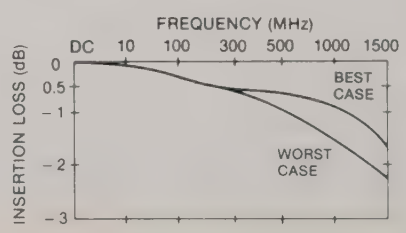
Insertion Loss: ⩽0.5 dB @ 100 MHz.
Bandwidth: ⩾1.5 GHz @ −3 dB.
Rise Time: ⩽0.5 ns.
Cross Talk: Any channel to any channel; all switches open:

10 MHz	100 MHz	1.5 GHz
⩽ −100 dB	⩽ −95 dB	⩽ −40 dB

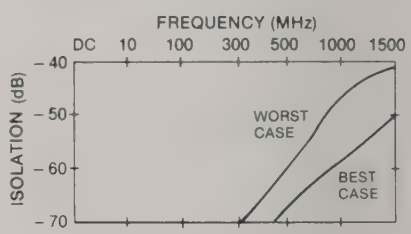
Isolation: One signal path, input to output; one switch open:

10 MHz	100 MHz	1.5 GHz
⩽ −100 dB	⩽ −90 dB	⩽ −40 dB

VSWR (Typical): ⩽1.1:1 @ 200 MHz, ⩽1.25:1 @ 500 MHz.
Max V/A/W: 100V, 2A, 60W.
Contact Resistance: ⩽0.25Ω/switch.
Switching Time: ⩽10 ms.
I/O Connections: 10 BNC, female.
Power Consumption:
3.3 W max @ 12V; 0.3 W per switch.
Typical Insertion Loss:



Typical Isolation:



FACTORY/FOB

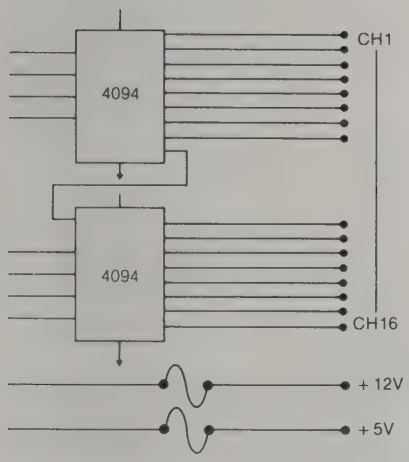
San Diego, CA

PRICE

Model 618 **$995**

Universal Breadboard Module

- **Custom Switch Module**
- **16 Channels**



Model 619, a breadboard module with all driver circuitry, breadboard space, and I/O terminals, gives you the option of building a custom switching module. The breadboard space, a 7 by 2.7 inch area with 0.1 inch universal hole pattern, provides an area for mounting many standard relays, IC's and components. You can program this "custom" module by addressing the 16 logic lines, just as you would address any switch on other modules. A "close" command causes the channel output to go high and an "open" command results in a low output.

SPECIFICATIONS

I/O Connections: Two terminal blocks with 12 screw connections each.
Driver Outputs: 16 channel low power (one LS TTL load per channel).
Supply Voltage: 300 mA max. at +12 V; 100 mA max at +5V.
Breadboard Space: 7 by 2.7 in.
Hole Pattern: 0.1 in. matrix (66 by 29 holes).
Hole Size: 0.046 in.
Maximum Allowable Component Height: Above board surface: 0.7 in. Below board surface: 0.15 in.
Maximum Allowable External Supply: 42 V, 1 A, 5 W.

FACTORY/FOB

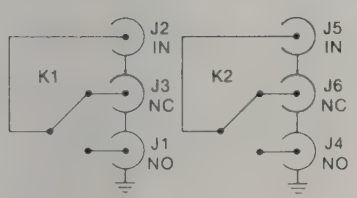
San Diego, CA

PRICE

Model 619 $250

DC to 26.5 GHz Microwave Switch Module

- **26.5 GHz Bandwidth**
- **Two Channels**

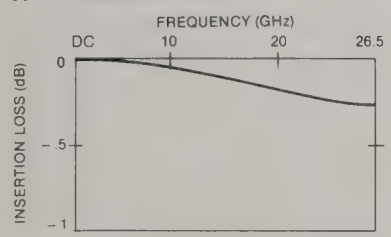


Model 620, a DC to 26.5 GHz microwave switch module, provides the maximum bandwidth available in a standard programmable plug-in. This module provides two channels of single-pole, double-throw, break-before-make switching with excellent power rating and 26.5 GHz bandwidth.

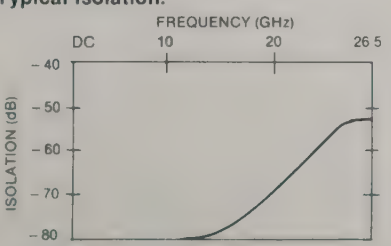
SPECIFICATIONS

Insertion Loss: ≤1 dB at 26.5 GHz.
Isolation: ≤ – 40 dB at 26.5 GHz;
≤ – 50 dB at 20 GHz;
≤ – 70 dB at 12.4 GHz.

Typical Insertion Loss:

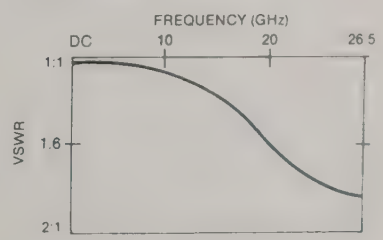


Typical Isolation:



Impedance: 50Ω.
VSWR: ≤1.65:1 at 26.5 GHz.
Switching Time: ≤15 ms.
Switching Power: 250W at 100 MHz derated to 15W at 26.5 GHz
I/O Connections: 6 SMA female connectors.
Power Consumption: 6W max at 12V; 3W per switch.

Typical VSWR:



FACTORY/FOB

San Diego, CA

PRICE

Model 620 $1195

Rack Mounting

ORDERING INSTRUCTIONS

If you want to install a Wavetek instrument in a standard 19 inch rack, locate the instrument model number in the table below, which lists a style or styles that the factory will use to adapt the instrument for rack mounting. Each style has a short description. Styles noted as standard come with the instrument at no extra cost. **When placing an order, please specify both the instrument model number and style number.** If none of these styles meet your needs, contact Wavetek or your local Wavetek representative. Catalog featured instruments not listed below are not rack mountable.

Rack Mounts and Adapters

Instrument	Panel/Adapter
20, 21, 22, 23, 75	6
132	1, 2, 10
143, 145, 148A	1, 2, 8
164, 166	10
171	8
172B	10*, S22
175, 178	10*, S20
182A	4, 5, 7
184 through 187	8
188, 190	4, 5, 7
191, 193	8
270, 271, 273, 275	12, 13, S20
278	12, 13, S20
432, 442, 452	Opt 04, M128
512/S, 541A, 716	11**
601, 602, 603	10*
650	16*, S22
751A, 752A, 753A	11*, M128
801, 802	8
816	11*, M134
852	Opt 04, M128
859	10*, S22
904, 907, 907A	10*
952, 954, 955, 957	14, 15
962, 964, 965, 967	14, 15
1018B	1031
1038 Series	Opt 01
1045/01	1047
1062, 1067-522	K015
1080, 1081	K019
1801C	K107
1901C	K107
2001	K015
2002B, 2005	K236
3000, 3006	K108
3510B, 3520	K234

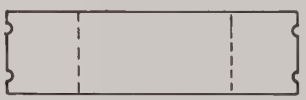
Rack Mounts and Adapters (Continued)

Instrument	Panel/Adapter
5100, 5110	11*, M128
5120A/5121A, 5130A/	11*, Opt 08
5131A, 5135A/5136A	11*, Opt 08
5155A/5156A	11*, Opt 08
6000, 6000A†	
8501, 8502	Opt 01

*Standard with instrument
**Standard with instrument Pem nuts installed for Chassis Trak drawer slides Model C300S-122
†Consult factory

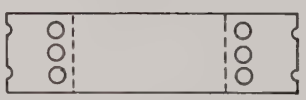
RACK MOUNT PANELS

Style 1 (Factory Only)



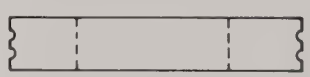
19 × 5¼ in. white solid panel. The instrument price will be increased.
Price Increase **$275**

Style 2 (Factory Only)



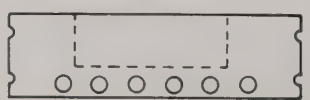
19 × 5¼ in. white solid panel. Instrument is center mounted between six feed-through BNCs as shown. The instrument price will be increased.
Price Increase **$350**

Style 4 (Factory Only)



19 × 3½ in. white solid panel. The instrument price will be increased.
Price Increase **$275**

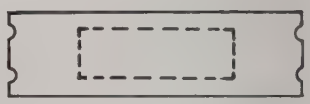
Style 5 (Factory Only)



19 × 5¼ in. white solid panel. Instrument is center mounted above six feed-through BNCs as shown. The instrument price will be increased.
Price Increase **$350**

RACK ADAPTERS

Style 6



19 × 5¼ in. light gray panel with cutout and support tray for 3.4 in. high instrument. (See table.) May be installed in field.
Kit Price **$100**

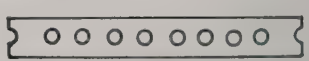
Style 7

19 × 5¼ in. white panel with cutout and support tray for 3½ in. high instrument. (See table.) May be installed in field.
Kit Price **$100**

Style 8

19 × 7 in. white panel with cutout and support tray for 5¼ in. high instrument. (See table.) May be installed in field.
Kit Price **$100**

Style 9



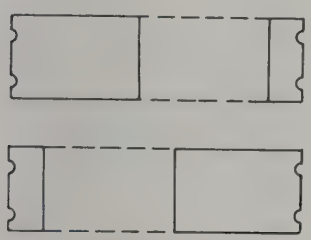
19 × 1¾ in. panel with eight feed-through BNC connectors.
Style 9-1 (White) **$125**
Style 9-2 (Lt. Gray) **$125**

Style 10

Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height and instrument is centered in the 19 in. rack.
Kit Price **$50**

Style 11
Pair of "ear" adapters (re style 10).
Kit Price **$35**

Style 12



Brackets and mounting hardware that allow right, left or center mounting of the instrument in a 19 in. rack.
Kit Price **$75**

Style 13
Dual rack mount handles and brackets that attach a pair of standard instruments together for rack mounting. Rack slides are available for dual mounting only. (See rack slides.)
Kit Price **$125**

Style 14 (Factory Only)
Brackets and mounting hardware that allow right or left mounting of the instrument in a 19 in. rack.
Instrument price will be increased.
Price Increase **$125**

Style 15 (Factory Only)
Dual rack mount brackets and hardware that attaches two instruments for side-by-side mounting in a 19 in. rack.
Instrument price will be increased.
Price Increase **$200**

Style 16
Pair of "ear" adapters (re style 10).
Kit Price **$50**

Style K015
Kit adapts the instrument for center mounting in a standard 19 × 5¼ in. rack.
Kit price **$75**

Style K019
Kit adapts the instrument for center mounting in a standard 19 × 7 in. rack.
Kit price **$75**

Style K107
Kit adapts the instrument for center mounting in a standard 19 × 9-7/8 in. rack.
Kit Price **$40**

Style K108
Kit adapts the instrument for center mounting in a standard 19 × 5¼ in. rack.
Kit price **$55**

Style K234
Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height.
Kit price **$75**

Style K236
Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height.
Kit price **$55**

RACK SLIDES

If your needs are not covered by these styles, consult the applicable instrument factory.

Style S20
20 in. slides. (270 series instruments must be dual mounted, style 13.)
FOB San Diego, CA **$150**

Style S22
22 in. slides.
FOB San Diego, CA **$150**

Style M128
22 in. slides.
FOB San Diego, CA **$250**

Style M134
22 in. slides.
FOB San Diego, CA **$250**

SPECIAL PAINT

Special paint is available on solid panel styles 1 through 5 only. For either Wavetek's paint or customer-furnished paint, there is an added cost above rack mounted instrument price.
Special Paint (Customer furnished) **$75**
Special Paint (Wavetek furnished) **$100**

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